POWER PLANT ENGINEERING

Established Over 32 Years

VOL. XXXII CHICAGO, JANUARY 15, 1928 No. 2

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Published on the 1st and 15th of each Month by the

Technical Publishing Co., 53 West Jackson Blvd., Chicago

New York Office, 150 Nassau Street

Subscription price $2.00 a year in the United States and possessions. Canada $2.75 a year. Other countries $3.50 a year. Single copies 15 cents.

Copyright 1928, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Member, Associated Business Papers, Audit Bureau of Circulations.

Circulation of this Issue 23,350

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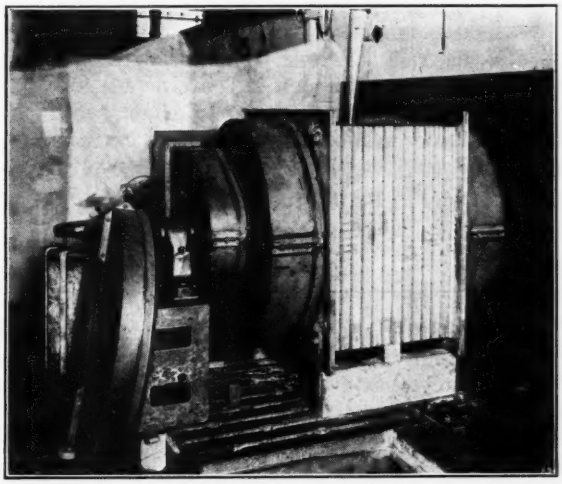


This Wooden Generator Wouldn't Generate

MAGNETIC CALCULATIONS in generator and motor design are always laborious and many an otherwise good electrical designer has been driven to drink over an attempt to whip a gang of unruly Oersteds and Maxwells into the organization of an equation. Indeed it is strange that these designers, usually bright lads with some imagination, have been willing to tolerate this nonsense of magnetic calculation. Why, in the name of common sense didn't they discard their foolish notions regarding magnetism in generator design and build a machine without magnetism?

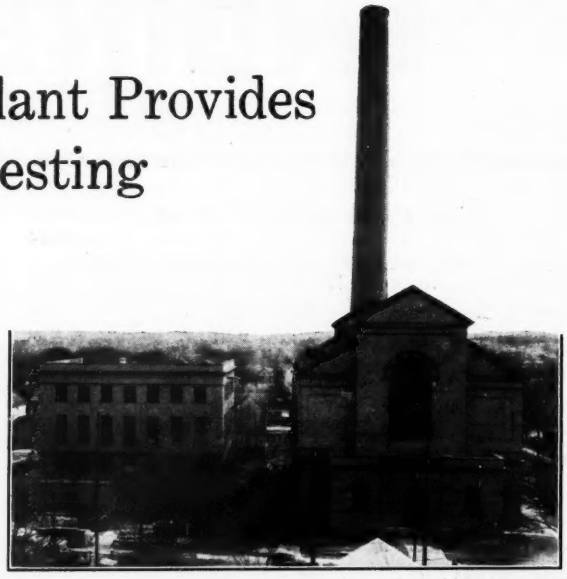
It has remained for the ingenious designers at the Westinghouse Electric and Manufacturing Co. to do this. Above, you see a picture of a wooden generator—a machine which with one clean sweep abolishes forever all laborious calculations in magnetism for the simple reason that it hasn't any. What could be sweeter? Not an Oersted nor a perm in the whole contraption!

But the funny part of this story is that when this wooden generator was finished, it wouldn't generate—not even sawdust. That, however, didn't worry the Westinghouse boys any for they never intended it to generate. What they were after was data on cooling and ventilation of generators. By building this small wooden model which in all its parts simulates those in a full size machine and in which any of the factors influencing ventilation can be controlled independently of the others, the ventilation characteristics of a large machine can be predicted, accurately.

University Heating Plant Provides Facilities for Testing

INCREASED HEATING REQUIREMENTS DUE TO UNPRECEDENTED GROWTH OF THE UNIVERSITY OF WISCONSIN RESULTED IN THE EXTENSION OF THE BOILER HOUSE AND THE INSTALLATION OF NEW, IMPROVED EQUIPMENT. PLANT NOW HEATS 89 BUILDINGS WITH A TOTAL OF 404,406 SQ. FT. OF CONNECTED RADIATION. PLANT IS ARRANGED TO PROVIDE TESTING FACILITIES FOR ENGINEERING STUDENTS

BY JOHN J. NOVOTNY*



DURING the year 1918-19, regents of the University of Wisconsin were confronted, not only with a big building program to provide the necessary classroom and research space and larger buildings for laboratories, administration and social activities but accompanying this was the problem of increasing services, such as heat, light, power and water.

After the war a decided increase of student enrollment appeared, jumping from about 5300 in 1917 to 7250 in 1920, then increasing gradually up to 8300 in 1926 and 9300 in 1927. Increase was evident in every department but several departments showed much the larger enrollment.

Previous to 1907, two small plants served the campus in groups, inadequately, while many of the outlying buildings had their own heating units. In the year 1907-08 the present heating system was built, located centrally as shown on Fig. 1 at 51, and with railroad facilities which effected a saving of about 50c per ton for hauling coal. As the university uses over 25,000 t. of coal a year, this item alone was important. At the time the plant was built, a large portion of the present tunnel system, indicated on Fig. 1, was laid out but much of it has been remodeled and increased in size since that time.

*Chief Operating Engineer.

IMPROVED BOILER GAVE LARGER CAPACITY

Design of the plant was for 12-350-hp. boilers with a Custodis brick chimney 250 by 14 ft. with ultimate capacity of 6000 hp. under natural draft. At the time, it was planned that an additional plant of like size would be built south of this chimney to take care of future extension but, with increased building program, study was made of the necessary boiler capacity to give efficient service and it was found that such progress has

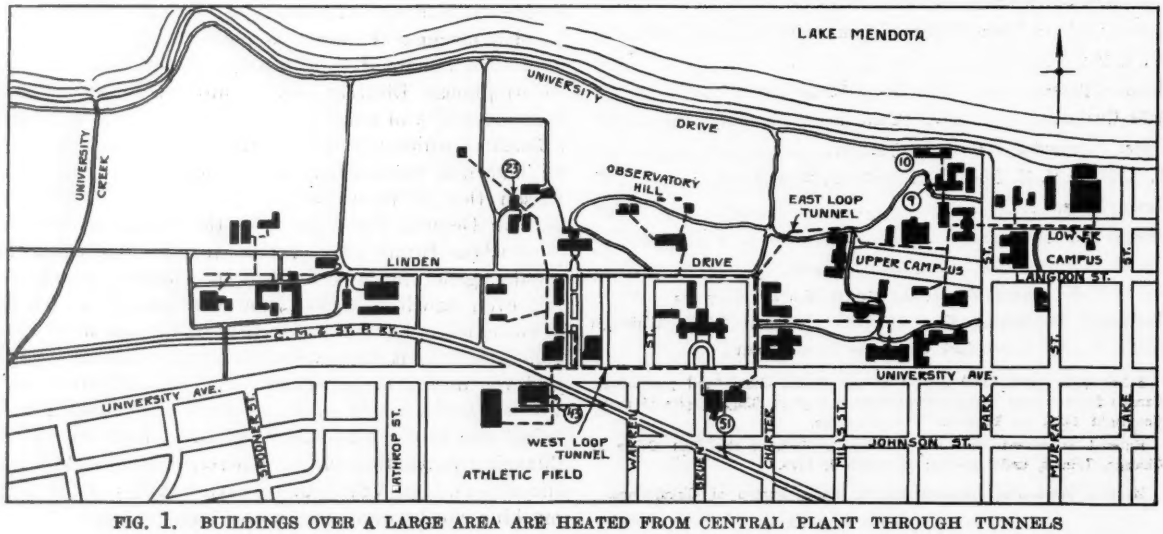


FIG. 1. BUILDINGS OVER A LARGE AREA ARE HEATED FROM CENTRAL PLANT THROUGH TUNNELS

been made in the art of building modern stokers and boilers that boilers of 516 hp. could be put in the same space occupied by the older 350-hp. units and, by installing underfeed forced draft stokers, ratings of 300 per cent could be obtained. Following this plan, the chimney capacity would care for almost double the ultimate plant capacity and, by removing old boilers and installing new style boilers and stokers as needed, it would also be possible to increase the plant efficiency from 10 to 15 per cent. Old boilers had been installed as needed in the plant, beginning in 1908 and early in 1923 one of these was removed, two 516-hp. boilers, known as Nos. 5 and 6 being installed, as shown in Fig. 2. Old breechings on the east side of the plant, which were unlined, had become so worn that, when new boilers were designed, a new breeching was built, enlarged to take care of 6-516-hp. boilers. This breeching was made of $\frac{3}{16}$-in. steel well braced with angle iron and lined inside with 2 in. of vitrabestos. Boiler design was changed to use the cross drum type, and steam headers were redesigned.

During the past year, units Nos. 11 and 12 were installed as 516-hp. boilers and the same changes were made on the west side of the plant.

It was necessary also to increase the size of the boiler feed lines throughout the plant and, in order to provide sufficient steam and exhaust mains for the present and future turbine fans or blowers, the supply lines had to be enlarged. Increased boiler capacity made it necessary also to install 2-4000-hp. Cochrane feed-water heaters, and the boiler feed pump was rebuilt; also a new boiler feed pump installed. Figure 5 shows the

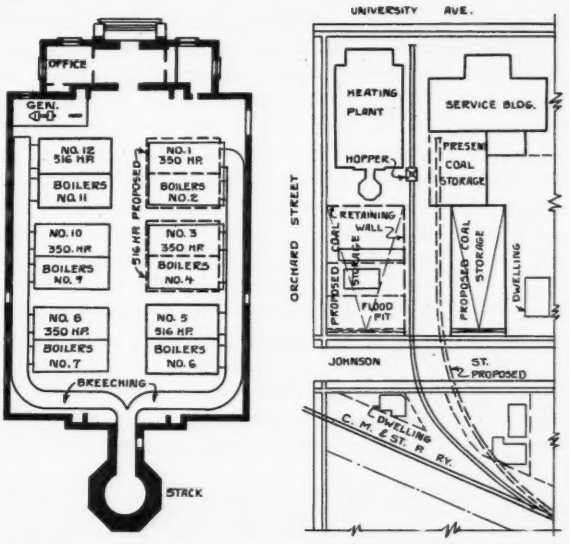


FIG. 2. 516-HP. BOILERS ARE REPLACING 350-HP. UNITS AND LARGER COAL STORAGE IS PLANNED

west side installation at the present time with Nos. 11 and 12 boilers of the new units and 7, 8, 9 and 10 of the old units.

Coal Bunkers Rebuilt

Figure 3 shows the construction of the coal bunkers. Originally they were flat bottom type with the hoppers at one side, so that coal, especially screenings, did not move freely. This caused fires in the bunkers and, at intervals, considerable inconvenience and damage, often

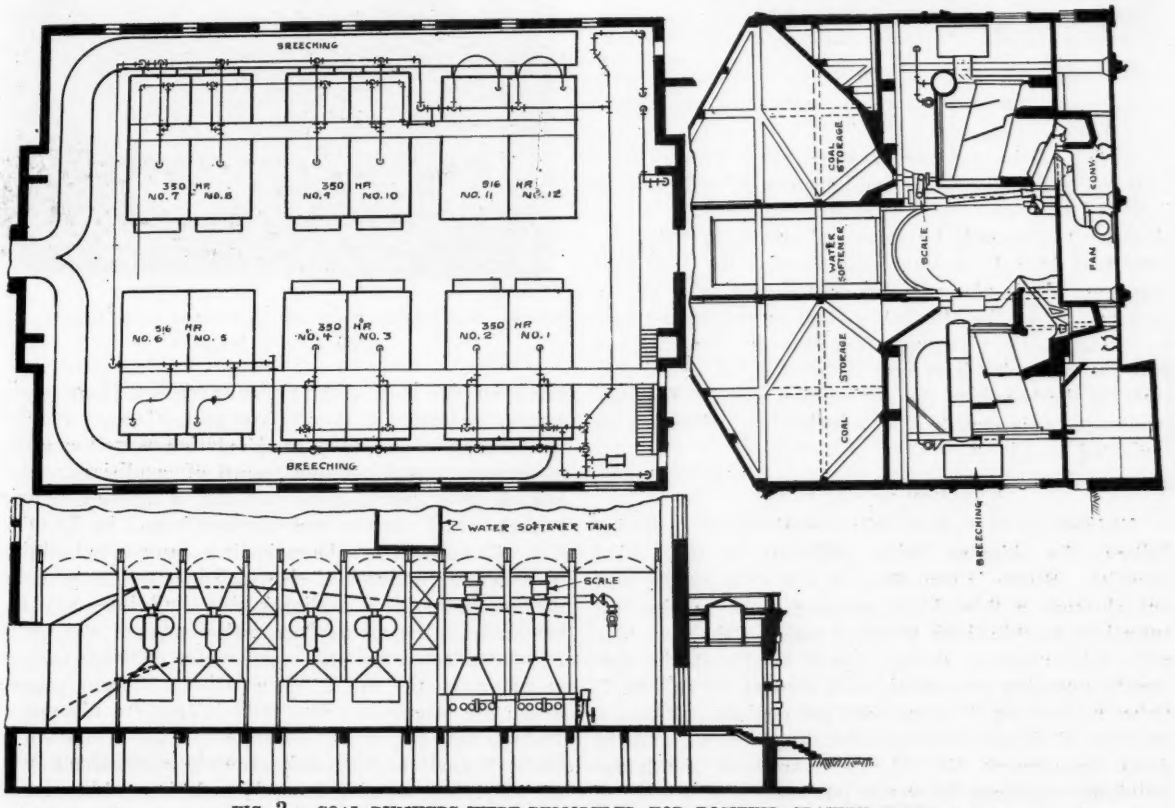


FIG. 3. COAL BUNKERS WERE REMODELED FOR POSITIVE GRAVITY FEED

curtailing efficient service. These bunkers were redesigned, made of reinforced concrete and with considerable pitch toward the hoppers. Although it reduced storage capacity, this could be well sacrificed and the change removed all troubles which were previously experienced. As it is now, the coal storage space in the plant has capacity of approximately 1500 t. on either side of the plant without trimming, these large spaces being divided into three bunkers of 500 t. each and one ash bunker which holds at least four carloads.

In Fig. 2 is seen the plan of outside storage which is to be redesigned and equipped with modern apparatus, as indicated on the illustration. Previous to 1923 arrangements were made for a shut-down of one or two weeks each year to clean the breechings and base of the smokestack and make necessary repairs. Since that time it is absolutely necessary to operate the station

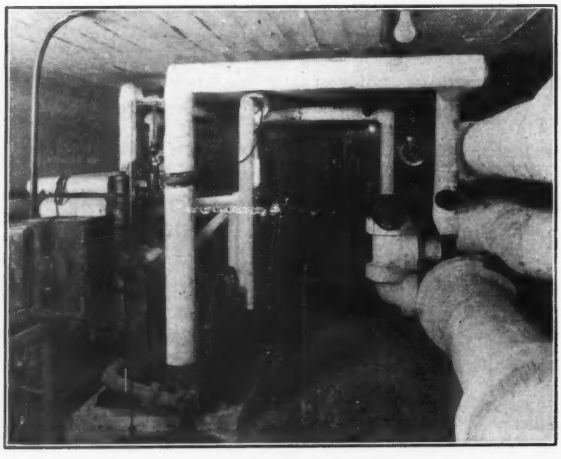


FIG. 4. NEW TUNNEL 6 BY 6½ FT. CARRIES LOW AND HIGH-PRESSURE MAINS, RETURN MAIN AND AIR LINE

every day of the year, so steam jet ash conveyors were installed to remove the soot and accumulation in breechings and at the foot of the stack. This refuse is now elevated to the ash bunkers and conveyed away by trucks or loaded on cars by means of the Link-Belt conveyor. It is planned, during the coming 2 yr., to remove four of the old 350-hp. boilers and install 516-hp. undoubtedly with underfeed stokers. Possibly one pair of coal pulverizers may be used as an added feature for the benefit of the engineering school. The contemplated replacements are of boilers 1, 2, 3 and 4, as indicated on Fig. 2.

Operation of the Plant

Ultimately, the plant will contain twelve 516-hp. boilers, the chimney being sufficient to serve that capacity. Steam is generated at 150 lb. gage and sent out through a 6-in. high pressure main in the east tunnel or an 8-in. high pressure main in the west tunnel. High-pressure steam is used chiefly at the university pumping station which is seen at 10 on Fig. 1. Other uses are in the steam and gas engineering laboratory, No. 9, forest products laboratory, No. 43, and the dairy department, No. 23. Also some of the larger buildings use steam for power purposes.

For heating buildings, steam is mainly reduced at the heating station by hydraulic operated reducing valves from 150 lb. to pressures of 1 to 8 lb. and is delivered into 16 and 14-in. mains as required. During the coldest weather, reducing valves are cut in between the high-pressure and low-pressure mains on the far ends of the system, which permits of carrying a lower pressure into the heating mains nearest the power plant, as it is found that the thermostatically-controlled buildings operate better when lower pressure is maintained on the system, also less heat is wasted. A Bristol electrical recorder is installed at the men's gymnasium, No. 1, at the farthest east end of the system and an-

FIG. 5. WEST SIDE OF BOILER ROOM HAS TWO 516-HP. AND FOUR 350-HP. BOILERS

other on the west end of the campus. These enable station operators to know how and when to regulate the main reducing valves at the station as well as giving a permanent and reliable record of conditions. Main heating lines shown on the map are in concrete or brick tunnels which vary in cross section from 7 by 7 to 6 by 6 ft. Branches from the main lines run to the buildings in concrete conduits of size sufficient to accommodate the necessary pipe. Eighty-nine buildings are now heated from the main plant with a total of 404,406 sq. ft. of connected radiation, caring for 39,083,857 cu. ft. or 97 cu. ft. per sq. ft. of radiation. Present tunnels, which are large enough to walk in, cover a distance of 2½ mi. and 1½ mi. of concrete conduit are provided. These tunnels and conduits contain approximately 13 mi. of piping, ranging from ¾ to 16-in. Older tunnels cost about $20 a linear foot but, since prices of labor

and material have advanced, present cost is approximately $50 a foot complete. Heating load represents approximately 72 per cent of the total steam generated, the balance, 28 per cent being divided about 13 per cent for power purposes and 15 per cent for hot water service.

Water Supply System

Over 3 mi. of lake water mains and about 2 mi. of city water mains are on the university grounds, the lake mains being supplied from the university pumping station, on the lake shore adjoining the electrical laboratory. The station furnishes from 1¼ to 2 million gal. of water a day for general service and has adequate capacity for fire protection. It is also used as a research laboratory for engineering students. Equipment at present is one 2,000,000-gal. opposed type twin pumping engine of Allis-Chalmers Co. make, one 1,000,000 gal. Laidlaw-Dunn-Gordon pumping engine, two old type duplex steam pumps, each with 5,000,000 gal. daily capacity and one Platt electric-driven centrifugal pump with capacity of 1500 gal. a minute. The pump house is equipped with large storage tanks, two air compressors, and two Venturi meters made by the Builders Iron Foundry.

Records of operation show that, from the year 1912 up to the present time, radiation connection has increased from 233,000 to 404,406 sq. ft., or approximately 73½ per cent. From 1922 to the present time the increase has been 30 per cent. During the 1912 to 1927 period, increase in the use of coal has been only 12 per cent, while increase from 1922 to 1927 was 30 per cent. It is expected that the present building program will soon create a connected load of over 500,000 sq. ft. of radiation. Records also show that the cost of heating per student of full semester attendance has decreased from $43.90 in 1918 to $18.53 in 1927, that the steam used per sq. ft. of radiation has decreased from 942 to 810, the coal cost per 1000 lb. of water evaporated has decreased from 27.9c to 24.9c, while the cost of coal per ton has increased from $4.20 to $4.30. Pounds of coal burned per cubic foot of building has decreased from 1.195 to 0.964 and the pounds of coal per boiler horsepower developed has decreased from 4.12 to 3.57. Evaporation per pound of coal has been increased from 7.52 to 8.65.

This increase of efficiency is largely the result of the installation of recording meters and also of more up-to-date and efficient boiler and stoker operation. Complete system of power plant records was made and devised in 1918 so that, with the aid of recording instruments, it was possible still further to reduce losses and note results. In 1918-19 makeup water amounted to from 30 to 40 per cent, while at the present time it is as low as 13 per cent. Recording instruments, condensate meters and steam flow meters have permitted reduction of losses in many buildings and services, largely

Principal Equipment at the Power Plant of the University of Wisconsin

Boiler Room Equipment

8 Babcock & Wilcox horizontal, water-tube boilers, 350 hp., 3500 sq. ft. heating surface, 200 lb. pressure.
4 Babcock & Wilcox cross-drum, water-tube boilers, 516 hp., 5160 sq. ft. heating surface, 200 lb. pressure.
8 Westinghouse stokers, 70 sq. ft. active grate area, natural draft, Westinghouse stoker engines.
4 Taylor stokers made by American Engineering Co., 96 sq. ft. grate area, 5 retorts, 26 tuyeres long, built for 225 per cent continuous rating and 275 per cent for 4 hours. Each stoker driven by either Louis Allis 4-speed motor or 7-hp. Troy engine; engines equipped with Waters governors.
4 Buffalo Forge Co. fans with louver dampers, Mason regulators, Kellholtz regulators and chronometer valves. One fan driven by 100-hp., a.c., 60-cycle 3-phase General Electric motor with push button control. Three fans driven by 57-hp. Terry steam turbines.
8 Ashton pop safety valves; 16 Consolidated pop safety valves.
12 Babcock & Wilcox water columns with Hancock blow down valves and Lunkenheimer emergency gage cocks.
12 Diamond soot blowers, 8 of 5-element and 4 of 8-element design.
8 Jenkins Bros. stop and check valves; 2 Golden Anderson stop and check valves; 2 Foster stop and check valves.
8 100-lb. gravity Avery coal scales, motor driven and with push button control.
2 Everlasting blowoff valves; 4 Lunkenheimer blowoff valves; 2 Fairbanks-Morse blowoff valves; 4 Eckenroth angle blowoff valves; 8 Yarway angle blowoff valves; 24 2½-in. Crane gate valves used as secondary blowoff valves.
12 "S-C" feed water regulators, 8 of 2-in. size and 4 of 2.5-in. size.
4 Link-Belt coal conveyors, 3 driven by 10-hp. motors and 1 by 2-hp. motor.
1 Link-Belt coal crusher driven by 20-hp. motor with push button control.
1 Set of Fairbanks-Morse twin track coal scales of 100 t. capacity with coal weighing beam inside the plant.
1 Link-Belt Caldwell car puller, motor driven.
1 Bucyrus steam clam shell bucket equipment. Coal storage inside plant 3000 t. and outside 8000 t.

Feed Water Equipment

2 Cochrane feed-water heaters operated singly or in parallel.
1 "S-C" regulator for removing air from heaters.
2 8-in. low-pressure Mason hydraulic operated reducing valves for heaters.
2 De Laval turbine-driven, 2-stage boiler feed pumps, 1 of 290 g.p.m. at 2500 r.p.m.; 1 150 g.p.m. at 3300 r.p.m.
2 12 by 7 by 12 in. Duplex Deane outside-packed pump; 1 12 by 8 by 20 Dean Bros. duplex outside-packed pump; 1 12 by 7 by 12 in. Marsh single-stroke outside-center-packed pump.
4 "S-C" boiler feed pump regulators.
1 Northern type continuous lime, soda and sodium aluminate water softener with quartz filter, capacity 6000 gal. per hour.
1 Bury air compressor, 100 cu. ft. of free air per min., steam-driven with automatic control, for temperature control system.
1 12 by 11 by 12 in. Westinghouse air compressor.
1 12 by 8 by 12 in. Ingersoll-Rand air compressor for general service.

Instruments for Plant Testing and Water Weighing

3 Venturi meters, 4 by 1⅝ in., 4 by 2 in., and 6 by 2½ in., indicating, recording and integrating type made by Builders Iron Foundry.
3 General Electric recording and indicating mechanical steam flow meter; 1 of 650 hp. capacity; 2 of 1500 hp. capacity.
2 Republic electrical steam flow meters, integrating, recording and indicating type of 700 hp. capacity.
2 General Electric indicating, recording and integrating steam flow meters of electrical design, 700 hp. capacity.
1 Brown electrical steam flow meter, indicating, recording and integrating, of 1500 hp. capacity.
1 Bailey indicating, recording and integrating steam flow, air flow and flue gas temperature recorder of 1500 hp. capacity; 1 of 650 hp. capacity.
14 12-in. steam pressure gages for 300 lb. pressure.
1 300-lb. master gage made by American Schaeffer & Budenberg Co.
10 Ellison differential draft gages.
2 A. W. Cash Co. Craig over-the-fire draft regulators.
2 National Regulator Co. Ajax damper regulators.
2 Bailey three-pointer and 2 four-pointer draft gages.
3 temperature recorders made by American Schaeffer & Budenberg Co.; 2 12-in. for feed water, 1 12-in. for return water, 1 12-in recorder for lake water pressure.
1 10-in. Bristol Co. feed-water pressure recorder.
3 Bristol Co. pressure recorders; 1 12-in. for high-pressure steam, 1 10-in. for air pressure, 1 12-in. for 0 to 15-lb. low-pressure steam.
2 10-in. long distance electrically operated low-pressure steam recorders.
6 12-in. Bristol flue gas thermometers, 0 to 800 deg.
2 10-t. Howe water weighing scales with tanks and 1 large water storage tank below scales.
1 Cement gun operated by compressed air.

Auxiliary Lighting and Heating Equipment

1 200 kv.a. Westinghouse turbine generator set and switchboard.
3 Mason reducing valves; 1 12-in. hydraulic, 1 6-in. hydraulic, 1 4-in. diaphragm design.
2 Yeomans Bros. sump pumps, 50 g.p.m. capacity.
1 American Well Works sump pump, 50 gal. capacity.

by a system of education of the operating force and constant check-up on leaks. It is not sufficient to evaporate 9 to 10 lb. of water per pound of coal in a well-designed heating station. It is just as important to know how much good you are getting from the heat in the steam at the point where it is used.

Plant Testing

Nearly every year, since 1909-10, complete efficiency tests on the plant have been made by the engineering students. This has aided greatly in locating sources of losses, besides being of value to the classes. Realizing the value of these tests, an appropriation was made in 1923 permitting larger and more up-to-date water-weighing tanks and scales were bought and installed so that it is now possible to make plant tests on either one or two boilers or on the whole plant even during the winter months, if desired. The plant is used at all times, by the engineering students for research work, such as plant inspection and plant testing, and it is of interest to note that steam and boiler feed piping were especially arranged for the testing of any or all boilers.

During the past year 1600 ft. of 6 by 6½-ft. concrete tunnels were completed and fully equipped with 14-in. low-pressure mains, 8-in. high-pressure mains, 6-in. returns and a 2-in. air line, a view in this tunnel being shown in Fig. 4. This completes the western circuit and gives another loop in addition to the east loop as indicated on Fig. 1. Previously, all main service went out from the northeast end of the plant, making the whole system depend on one circuit, which made repairs difficult without cutting off many services. The new tunnel will cost approximately $41 a foot installed. When needed to accommodate future buildings, tunnels will be laid out so as to obtain a direct path for the steam and, at the same time, secure a loop from the heating station. Originally the plant was designed by Professor Storm Bull, who died in 1908. The heating station was completed under the direction of Professor H. J. Torkelson, former consulting engineer and business manager who had keen foresight in laying out the original tunnel systems. Professor G. L. Larson of the Steam and Gas Engineering Department has been consulting engineer for the University since 1918, and has been assisted by Messrs. Arthur Peabody and J. C. White of the station engineering department. These men, together with A. S. Gallistel, superintendent of Buildings and Grounds, and the writer of this article designed the rebuilding of the present plant.

It is interesting and gratifying to report that no delays or inconveniences have occurred thus far during the remodeling period and that records show a steady and considerable increase of efficiency.

FIG. 6. THESE PUMPS HAVE A CAPACITY OF 6,100,000 GAL. A DAY

Refinement Characterizes New Equipment

PROGRESS IN THE DESIGN OF POWER PLANT EQUIPMENT IS INDICATED BY REFINEMENT OF DETAIL RATHER THAN RADICAL CHANGES

IF SOME ASTUTE mathematician were given the necessary facts (assuming they were available) for determining the laws which govern the development of mechanical and electrical equipment, it is probable that he would find these laws to be similar to those which govern the growth of living things. Development of such equipment would no doubt follow some such general truth as the compound interest law which biologists find also govern the growth of plants. In other words the rate of increase in new equipments or improvements is, no doubt, proportional to the state of development of the field itself.

One thing leads to another. There could be no improvement in the recording pen of a recording flow meter until the flow meter itself had been developed. Similarly a frequency meter, reading to 1/100 of a second would not have been developed until the necessity for such close frequency control became desirable. Steam pressure gages capable of measuring to 1200 lb. per sq. in. are the direct result of the development of the 1200-lb. boiler. In this way the development of one new piece of equipment makes necessary the development of a score of accessories. Each accessory then becomes the subject of further improvement. And so on, *ad infinitum*.

Each year we are confronted by a greater number of new developments than the year previous and each year presents us with an increasing number of problems to be solved. Any attempt, therefore, to record the new developments in a particular field becomes increasingly difficult with time.

In the case of power plant equipment, it is obviously impossible to cover all the improvements and new developments in a single issue, so, in this issue we have confined our discussions of new equipment to only a few special branches of the field. The selection of the classes of equipment covered in the following pages is perhaps somewhat inconsistent but all of the equipment is cahracterized by improvements which are of considerable interest.

Turbine development, for instance, this year was notable for the construction of extremely large units.

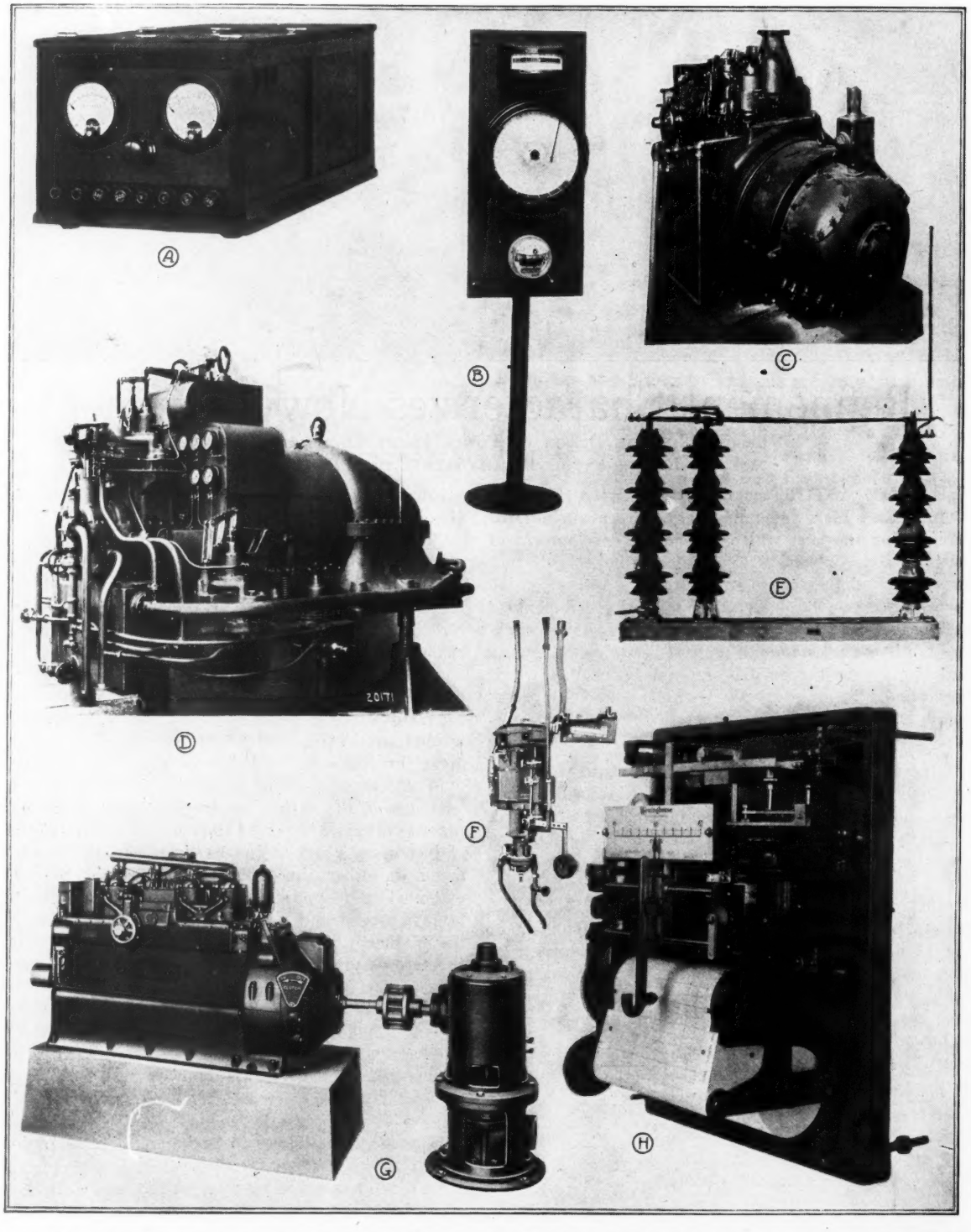
In the boiler room, the most interesting thing at the present time, perhaps, is the methods being used for the automatic control of combustion. The human element is gradually being eliminated and mechanical and electrical equipment is becoming increasingly reliable.

What is true of combustion control is also true of feed water control equipment. Here too, the control is being given over almost entirely to automatic apparatus.

The measurement of quantities, pressures and temperatures of the various commodities used in the power plant is always of greatest importance and development of instruments and meters has kept pace with developments in other lines. Wattmeter ranges have been extended, new voltmeters produced, flowmeters have been improved and a new frequency recorder measures the frequency with far greater accuracy than anything heretofore produced. For calibrating and testing, meters new devices and methods have been developed, one of the most interesting being one in which a ray of light acting on a photo-electric cell is used. The use of the photo-electric cell and the thermionic vacuum tube is being extended to many fields.

So, in all branches of the field progress has been steady. Startlingly new discoveries these days are rare. With many investigators working on similar problems it is extremely difficult for one or even one group of inventors to produce anything radically new. The great improvements in the power plant today are due to organized cooperative effort not only among the manufacturers but between the manufacturers and the operators. Each has come to have a more tolerant regard for the other's problems, with the result that instead of antagonizing each other they are working together for their mutual advantage.

Examples of Equipment Developed in 1927



A. With the development of frequency meters reading to 1/100 cycle, highly accurate devices for creating frequencies of known value had to be built. This shows an instrument of this kind for producing test frequencies. B. New Type MP-134 recording, integrating and indicating electrically operated flow meter panel. C. An 18-kw. Diesel generating set used for battery charging. D. 1000-kw. turbine in which the entire input is bled and returned to the machine at a lower pressure. E. A modern 154,000-v. air break switch for outdoor service. F. Automatic back pressure regulator for feed pump control. G. Light weight Diesel engine arranged for connection through a speed increaser to a turbine pump. H. A recording frequency meter capable of registering frequency to 1/100 cycle.

Turbine and Turbo-Generator Equipment

RECORD BREAKING TURBINES, GENERATORS AND IMPORTANT INDUSTRIAL APPLICATIONS MARK YEAR'S PROGRESS

NOT ONLY in impressive sizes, but in types, pressures, cycles and industrial applications as well, the past year has set the high mark for accomplishment in the turbine and turbo-generator field.

For the first time a unit, the 91,500-kw. cross compound machine at Crawford Station of the Commonwealth Edison Co., has developed 100,000 kw. This is also the first unit to operate on the reheat cycle with a steam reheater or heat exchanger. Previously reheating had been done only in special reheat boilers of the type installed for the first units at Crawford, Philo, Twin Branch, Columbia and Stanton.

At Edgar Station of the Edison Electric Illuminating Company of Boston, a record breaking turbine of 65,000-kw. single cylinder unit has been put in service, but will soon be exceeded as the largest single cylinder turbine in operation by the 75,000-kw. unit now under construction for Huntley Station of the Buffalo General Electric Co.

Improvements in generator construction have been noteworthy and of such magnitude that the largest generators can now be shipped assembled. The generator for the 94,000-kw. tandem compound unit for Long Beach Steam Plant No. 3 of the Southern California Edison Co., formerly the largest single generator unit to be designed, has been tested and will soon be shipped assembled.

Developments along the line of generator construction have made it possible to design a single generator machine of 160,000 kw., almost twice the size of the Long Beach generator. This unit will be installed in the East River Station of the New York Edison Co. and the steam end will be tandem compound with single flow high pressure element and a double flow low pressure element.

An unusual feature of the construction of this generator is the fact that the stator winding is composed of two separate windings which are identical in all respects, but are electrically separate, so that the capacity of each is 80,000 kw. The two windings are connected through two generator breakers to adjacent bus sections. This construction allows a reduction in generator breaker capacity, the elimination of bus reactors and increased stability.

SPEEDS MATERIALLY INCREASED

Increased speed made possible by experiments and construction improvements has been remarkable. The 168,000-kw., two cylinder unit for the Hell Gate Station of the United Electric Light & Power Co. will operate at 1800 r.p.m. Last year 50,000 kw. was considered the limit for 1800 r.p.m. machines. These two generators will also be shipped completely assembled. As yet the triple 208,000-kw. unit now under construction for State Line Station is the largest one designed. It will operate at 22,000 v. Materials and design of installation for this voltage have been unusually extensive and complete.

In the turbine field industrial requirements have not been neglected, and advances in this field have been as important as the progress made in central station field. New designs of 1800 and 3600 r.p.m. machines have raised the capacities to 15,000 and 10,000 kw. respectively for these speeds. Bleeder and high back pressure machines are assuming increased importance. At the Robinson Illinois Refinery of the Lincoln Refining Co., a 1000-kw. turbine receives steam at 250 lb., bleeds it all at the first stage at 125 lb. for use in the refinery, the steam being returned to the turbine slightly above atmospheric pressure for expansion in the condenser.

At the Solvay Co. plant in Syracuse, N. Y., a 4750 kw. 900 lb. 125 lb. back pressure turbine has been in successful operation for several months. Another 3000 kw., 12-stage non-condensing turbine will operate at 400 lb. 150 deg. superheat, 125 lb. back pressure at a plant of the International Paper Co.

EXTRACTION FOR PROCESS WORK NOW COMMON

Extraction from 50 to 175 lb. for process work is now common and a number of such units have been put in operation during the past year. Turbo blowers are also an important industrial product and they have received considerable attention, especially for blast furnace and Bessemer converter service. One company reports an installation of turbo-propeller type units to deliver 276,000 cu. ft. of air per min. against 15 lb. static pressure, which will occupy a floor space of but 5 by 17 ft.

Probably the 1200 lb. and mercury vapor plants have created more interest than any development since the reheat cycle. Results gained from the past year or two years' operation in plants of this kind have been responsible for additional larger units in both fields. The third 1200-lb. turbine in this country has been placed in commercial operation. It is the 10,000-kw. unit of the Edgar Station. A fourth 1200 lb. installation is planned for an addition to the Northeast Station of the Kansas City Power & Light Co. This will be a 10,000-kw. turbine and the order for it has already been placed.

Early in 1927 construction was begun on a large commercial mercury boiler and turbine unit for the South Meadow Station of the Hartford Electric Light Co. The installation of this unit was made as a result of the operation of the 1800-kw., three-stage mercury turbine installed at the Dutch Point Station of the above company in 1925.

The new turbine is expected to deliver 10,000 kw. when burning 14,500 lb. of coal per hour in a furnace. In addition, the condensing mercury will generate some 125,000 lb. of steam per hour, which will be superheated to 700 deg. F. by the waste gases from the mercury boiler furnace.

MERCURY RETURNED TO BOILER BY GRAVITY

The equipment is designed for a mercury pressure of 70 lb. gage and a steam pressure of 350 lb. gage, the turbine is a 5-stage, 720-r.p.m. machine, having an overhung rotor, the complete weight of the revolving parts of the turbine and generator being carried on

the two generator bearings. The mercury vapor flows through the turbine towards the generator so that the shaft packing is at the low pressure end of the machine. After passing through the turbine the mercury vapor exhausts to the two condensers placed at each side, the vapor delivering its heat of condensation to vertical dead ended tubes containing water. Upon condensing the mercury passes to a cleaning sump and then by gravity flow to the boiler.

Manufacturers' Statements

STATEMENT BY THE AMERICAN BROWN BOVERI ELECTRIC CORP., NEW YORK, N. Y.

SEVERAL turbo generators of the type illustrated by the enclosed photograph and cross section have been placed in operation by the Brown Boveri Co. of coupling. One of these units of particular interest is

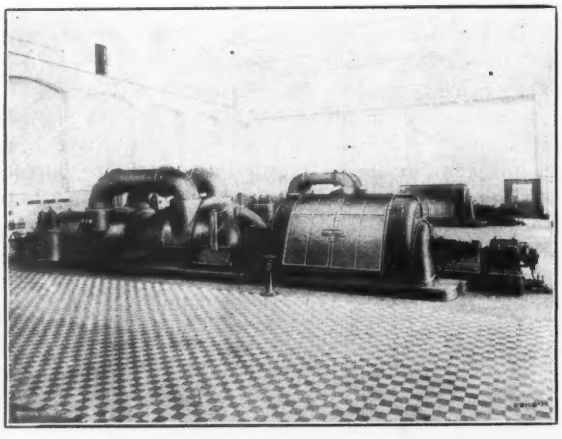


FIG. 1. PHOTOGRAPH OF THE 50,000 KW. 1500 R.P.M. BROWN BOVERI TURBO-GENERATOR IN THE GENNEVILLIERS PLANT NEAR PARIS

FIG. 3. INNER STATOR FRAME WITH STACK LAMINATIONS OF THE GENERAL ELECTRIC 100,000-KV.A. GENERATOR FOR LONG BEACH STEAM PLANT NO. 3

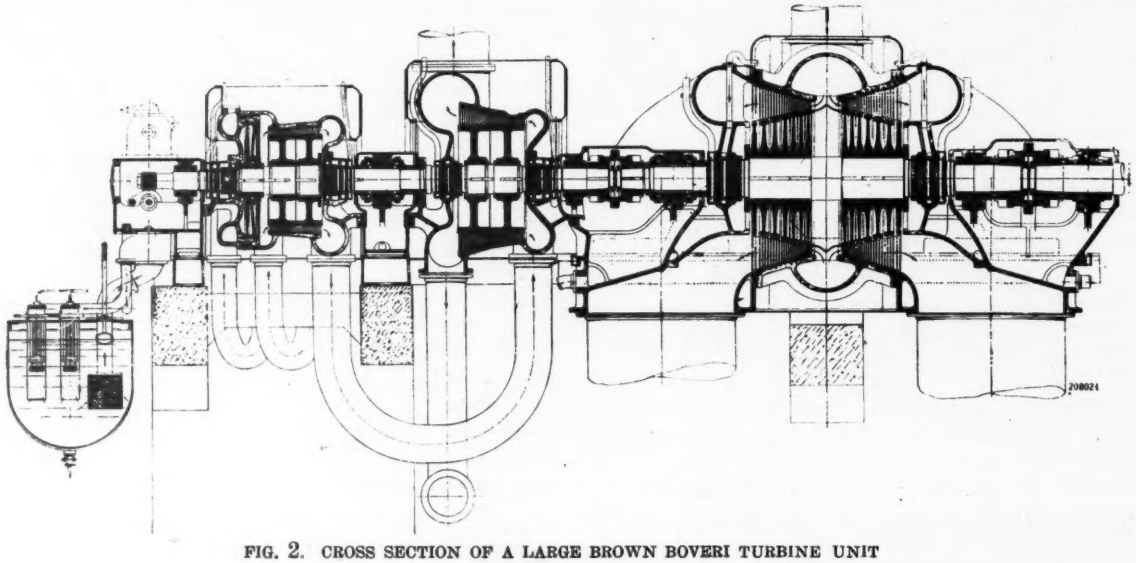


FIG. 2. CROSS SECTION OF A LARGE BROWN BOVERI TURBINE UNIT

Europe with success both from an operating and economy standpoint. Authentic tests have been made on some of these units which indicate turbine efficiencies in the order of 85 per cent or more at the turbine

the 50,000-kw., 1500-r.p.m. unit placed in operation at the Gennevilliers station near Paris. This unit is operated with steam conditions of 375 lb. gage, 700 deg. F. total steam temperature and forms an important source of power supply for the City of Paris.

To emphasize the great reliability of this equipment, Brown Boveri has received over 50 orders during the past three years of units ranging from 15,000 kw. to 50,000 kw.

STATEMENT BY THE GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

IN THE FIELD of high steam pressures a 10,000-kw., 1200 lb. per sq. in. turbo generator unit was put in service in the Edgar Station of the Boston Edison Co. The turbine exhausts at 375 lb. into the main steam line of the station.

A new record in size of single cylinder steam turbine

units was reached during the year in the 65,000-kw. set placed in service by the Boston Edison Co. At the present time a 75,000-kw. single cylinder unit is under construction.

In smaller capacities new designs of 15,000-kw., 1800-r.p.m. and 10,000-kw., 3600-r.p.m. units were developed to embody in their construction all the new features which would tend to increase the efficiency of machines of this capacity.

Long Beach 94,000-Kw. Turbine Now on Test

In tandem compound single generator units a 94,000-kw. set now on test will soon be delivered and put in operation at the Southern California Edison Co. As a result of recent developments it has been practical to design a 160,000-kw. generator for the New York Edison Co. This machine will be installed in the East River Station in New York City and will operate at 1500 r.p.m. and 25 cycles. An unusual feature of this generator is that there are two separate stator windings each rated at 80,000 kw. These are connected through two generator bracers to adjacent cross sections. The steam end is tandem compound with the single generator for the Southern California Edison Co., which will be shipped assembled.

Mercury Vapor Process

The 1800-kw., three-stage mercury turbine equipment at the Dutch Point Station of the Hartford Electric Light & Power Co. installed in 1925 continues to operate over long periods in a manner to warrant the building of a larger unit.

Early in 1927, therefore, construction was begun on larger mercury boiler turbine unit to be installed in the South Meadow Station of the same company. The new unit will be rated at 10,000 kw. when burning about 14,500 lb. of coal per hour and will generate some 125,000 lb. of steam per hour. This steam will then be superheated to 700 deg. F.

Statement by the Moore Steam Turbine Corp., Wellsville, N. Y.

To meet the demand for a highly efficient steam turbine for driving moderate speed auxiliaries, such as fans, blowers, pumps and generators, a combined turbine and reduction gear has been developed by the Moore Steam Turbine Corp.

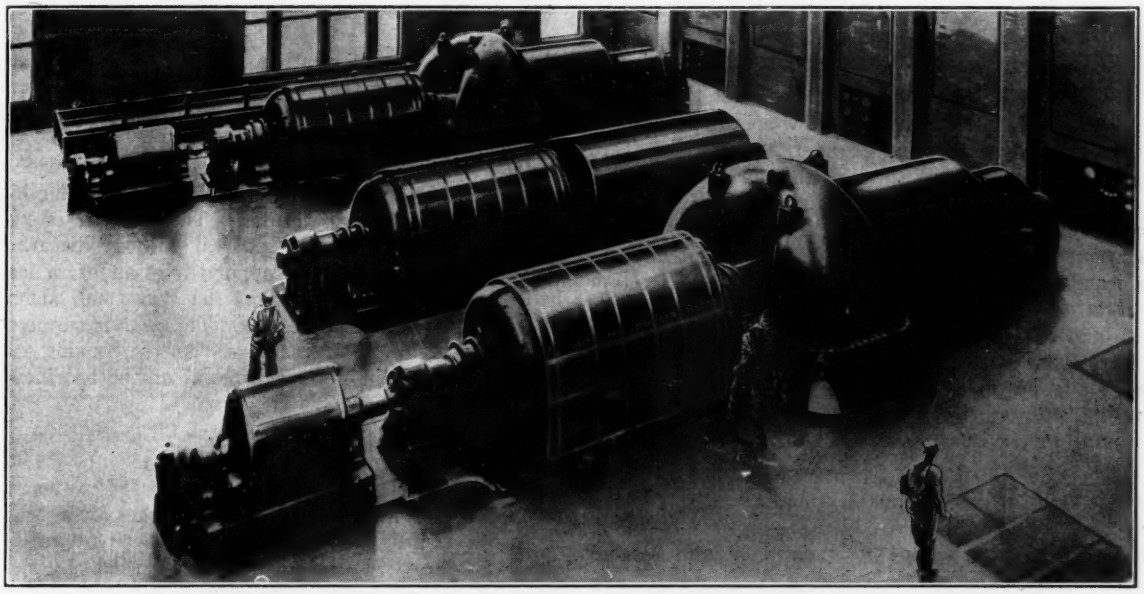


FIG. 4. DRAWING OF THE 165,000-KW. TRIPLE COMPOUND TURBINE GENERATOR FOR THE PHILO STATION

flow high pressure element and the double flow low pressure element.

In cross compound units the construction of a 165,000-kw. triple, 60-cycle turbo generator set for the Philo Station of the Ohio Power Co. is well under way. Turbines of this set operate at 600 lb. pressure and 725 deg. F. The 208,000 kw. triple unit for the State Line Generating Co. is under construction.

Large Generators Now Shipped Assembled

Another advance in turbine generator construction is the fabrication of armature frames, which minimize the foundation requirements and make it possible to ship completely assembled and wound machines of much greater capacity than was possible with cast frames. An example of this construction is the 100,000-kv.a.

For driving machine speeds below 2000 r.p.m. the steam consumption of the combined turbine and reduction gear is much lower than that of a direct connected turbine, while the simplicity of operation, ease of mounting and reliability are equally good. The slightly higher cost of the unit is soon returned by the saving of steam. A view of this unit is shown. It is built in sizes ranging from 5 to 60 hp.

Gears have been redesigned during the past year, to provide better lubrication, do away with external coolers and reservoirs and simplify oil piping. As shown in cross section, the gear case has been widened at the bottom to provide an ample oil reservoir within the casing and the cooling chambers on the side of the casings are cast with one side open to allow thorough cleaning and inspection.

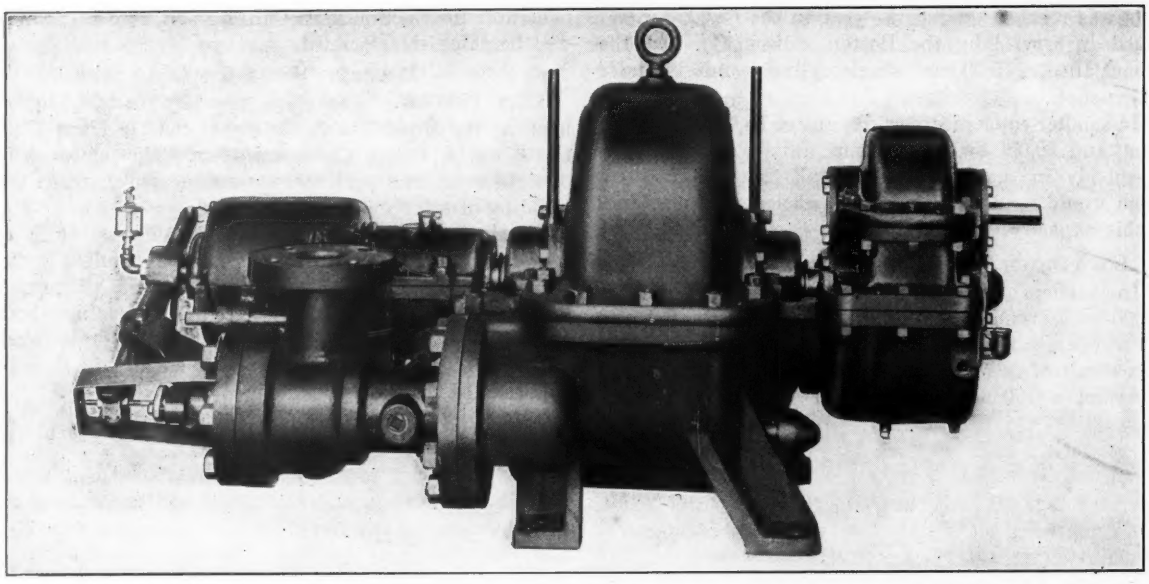


FIG. 5. THE NEW MOORE COMBINED TURBINE AND REDUCTION GEAR DEVELOPED FOR DRIVING MODERATE SPEED AUXILIARIES SUCH AS FANS, BLOWERS, PUMPS AND GENERATORS

in the design of new type of turbines which consciously

Lubricating Oil Supplied by a Gear Pump

A gear pump driven from the low speed shaft forces oil for lubrication into the channel A and from there it is bled to channel B through the spray tube. The oil is under pressure in these channels and enters each bearing through the same slot through which the oil rings run. The spray tube delivers a spray of oil onto the gear teeth at the point of mesh. When the direction of rotation requires, the spray tube passes above the gears and sprays downward. Oil pressure is controlled by a relief valve built into the gear case cover to discharge any surplus oil back to the reservoir. An oil flow indicator at the end of the system farthest from the pump gives visual assurance of oil flow to all parts.

Oil Piping Is Simplified

Oil rings furnish an immediate supply of oil to the bearings when starting, avoiding possible wear during the first few turns before oil from the pump reaches

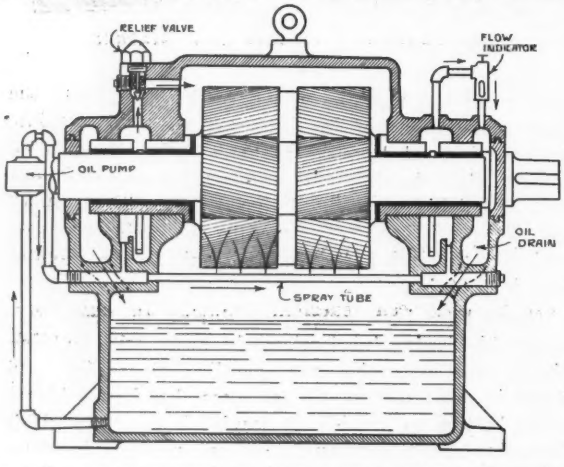


FIG. 6. CROSS SECTION OF THE MOORE GEARS USED WITH THE NEW GEARED TURBINE UNIT

all parts of the lubricating system. With this new design greater compactness and simplicity are secured and the elimination of most the usual oil piping meets the approval of the experienced operator.

The governor end bearing of the turbine is made of non-scoring bronze which is especially suitable for high speeds and high temperatures. The bearing is horizontally split to facilitate removal without disturbing the shaft. The pinion is supported by an extra large ball bearing which also absorbs the very small amount of thrust of the reduction gear. The gear is supported by either ball or roller bearings. As the bearing seats are all made to limit gages renewal of the bearings is simple.

Statement by Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Like the onset of a rising flood of water the advance of electricity has level stretches over which it rushes rapidly and steep slopes where progress is slow. People were astonished at commercial electricity when it first appeared, as they were astonished at the first stages of the Mississippi Flood, but time makes both of them seem a matter of course. The flood is gone, leaving ruin behind it, but the tide of electrical progress still rises, bringing with it prosperity. An examination of widely scattered landmarks shows how far it has advanced in the past twelve months. Steam shows no sign of losing its place as the main source of power. It can be placed to some degree at will as investment cost is moderate and size of unit and plant should be as large as desired and it is very often cheaper than water power.

Turbines continue to grow larger—larger sets—larger single units—increased speeds at high ratings and continued tendency to high pressures. Industrial turbines designed for generating power in connection with process steam are interesting and of increasing importance. The general demand for beauty which is becoming evident in every industry has been recognized

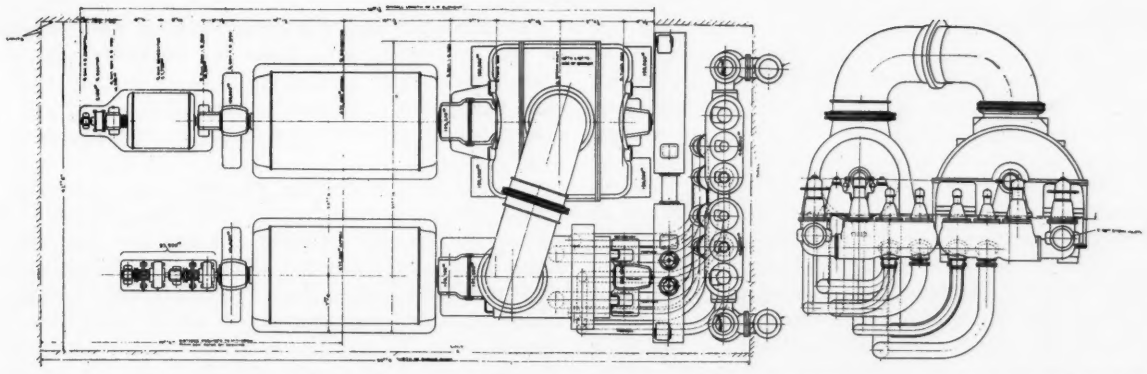


FIG. 7. PLAN AND END ELEVATION OF THE 168,000-KW., CROSS COMPOUND WESTINGHOUSE UNIT FOR THE HELL GATE STATION

plan to please the eye as well as the engineering sense. Small turbines merit and have received careful efforts.

The limit in unit size is raised by the last unit for the Hell Gate Station of the United Electric Light & Power Co. This is a 168,000-kw. machine in two cylinders and the speed, 1800 r.p.m. is unprecedented in so large a machine. The plan and end elevation of this machine is shown.

Another 1200 Lb. Installation to Be Made

Another interesting development is the 10,000-kw., 1200 lb. pressure turbine under construction for the Northeast Station of the Kansas City Power & Light Co. It exhausts at 300 lb. pressure into the station header feeding the standard pressure turbines.

A 900-lb. pressure, 4750-kw. industrial turbine is in highly satisfactory service. Other interesting turbines include one for 15,000 kw., two of 30,000 kw. and two of 50,000 kw., of design inducive to high economy and improved reliability. The 50,000-kw. machines are fitted with a hydraulic impeller governor, as shown in cross section in the reproduced drawing.

Industrial turbine development has been important and the application of the bleeder type is rapidly widening. One 1000-kw. turbine bleeds its whole steam flow for process work and then takes in 75 per cent of the original flow at atmosphere and expands it in final exhaust vacuum. It has special governing arrangement. A photograph of this turbine is shown. It is installed in an oil refinery.

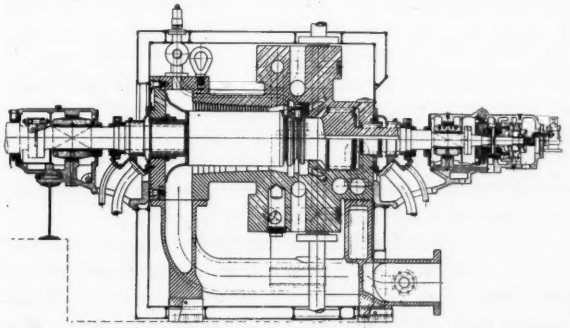


FIG. 8. CROSS SECTION OF THE 10,000-KW., 1200-LB. PRESSURE WESTINGHOUSE TURBINE FOR THE NORTHEAST STATION

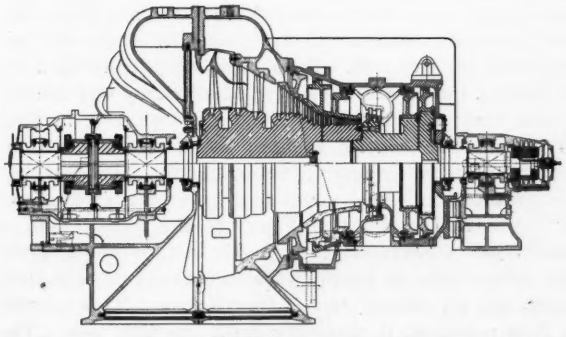


FIG. 9. ONE OF THE 50,000-KW. WESTINGHOUSE TURBINES NOW UNDER CONSTRUCTION

Turbine Blowers

A compact efficient turbine propeller blower unit requiring a space 5 ft. in diameter by 7½ ft. long and rated at 75,000 cu. ft. of air per min. against 10 in. static pressure has been perfected. On test it delivered 105,000 cu. ft. per min. against 8 in. static pressure. The impeller type oil governor allows remote control of these units. Three such blowers rated at 276,000 cu.

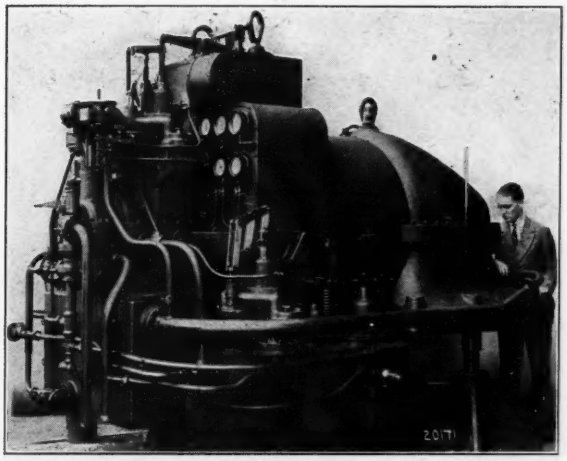


FIG. 10. PHOTOGRAPH OF A WESTINGHOUSE 1000-KW. INDUSTRIAL TURBINE WHICH BLEEDS ALL THE STEAM AT 125 LB. PRESSURE AND RETURNS 75 PER CENT OF IT BACK TO THE TURBINE AT ATMOSPHERIC PRESSURE FOR EXPANSION TO CONDENSER PRESSURE

ft. per min. against 15 in. static head will occupy but 5 by 17 ft. floor space.

Capacities of turbo-generator far surpass its nearest rival, the water driven generator, but is still growing rapidly, carrying higher speeds for the larger ratings. The limiting size still some distance away, seems to be the heaviest rotor the railroads will carry. Westinghouse has cars up to 275,000 lb. although no rotors so far undertaken approach that weight. Changes in design such as new and stronger steel for rotors, and structural steel construction for stators, have raised other size limits. More reliable stator installation has resulted from a new mica bond with little dielectric loss, and which does not swell. Turbine generator rotors are held together by long screw bolts of huge size. Formerly great force was needed to screw up the nuts. Now a bolt puller stretches these bolts and the nut is tightened without distortion of the bolts, and with greater uniformity of tightness on the rotor. A view of this bolt puller is shown in the headpiece page 107.

Demands for higher generator ratings have resulted in the hydrogen cooled generator of 7500 kv.a., 600 r.p.m. being built to determine the efficiency of the seals and joints, the possible increase in rating and to demonstrate the various devices for maintaining proper gas density.

A pair of 94,000-kv.a., 85 per cent power factor 1800-r.p.m. generators for the Hell Gate Station to be driven by the unit mentioned above are the largest single units ever built for 1800 r.p.m. Owing to the structural steel design, these generators will be shipped completely built and wound. A set of generators for the Brooklyn Edison Co. 110,000-kw. cross compound unit will consist of a pair of 68,750-kv.a., 80 per cent power factor, 1800-r.p.m. generators.

Structural steel design is further development of the skeleton frame mentioned last year, which allows complete shipment of 1800-r.p.m. machines up to 75,000 kv.a. Previously machines larger than 12,500 kv.a. had to be shipped in sections and assembled in the field.

Developments in Combustion Control Equipment

ELECTRICALLY OPERATED COMBUSTION CONTROL SYSTEMS, MEANS FOR CONTROL OF AIR ZONES UNDER BOTH CHAIN GRATE AND UNDERFEED STOKERS AND IMPROVEMENTS IN CONSTRUCTION OF APPARATUS

DURING THE PAST year, developments have been made in automatic combustion control equipment to keep pace with the demands for such equipment to be used under extremely varied operating conditions in all types of central stations and industrial power plants. Many of these developments have taken the form of improvements in existing devices, although several electrically-operated systems have been placed on the market. Automatic control of individual air zones of both chain grate and underfeed stokers has been announced. Component parts of systems such as control drives, power units, regulators and the like have been redesigned and improved.

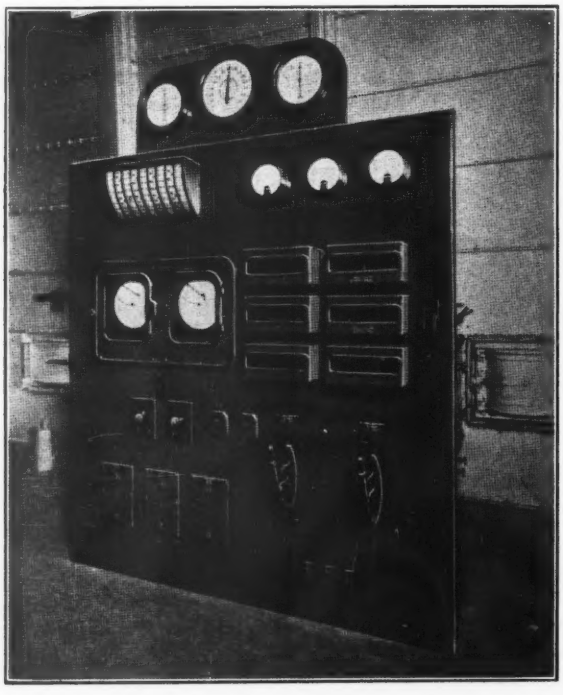


FIG. 1. BOILER CONTROL BOARD IN A MODERN HIGH PRESSURE CENTRAL STATION

On the steam-flow-air-flow system of automatic combustion control, a new form of control drive has been developed. One of its principal features is its compactness, making it adaptable for installation close to the equipment to be controlled. It can be supported on walls or structural members and this feature may often prove convenient in eliminating gearing and shafting. It will not entirely supersede the larger type, however, which will still be used when zero reset mechanism and other features are required.

Control of individual air zones of chain grate stokers is now possible with a new form of automatic control announced this year. Figure 4 shows the fuel bed conditions that may obtain at different ratings on such a stoker with different ratings of the boiler. At 75 per cent of rating, the active fuel bed covers the first three zones, the diagram showing the air distribution. The fourth and fifth zone dampers are closed. When the load increases, the control mechanism increases the fuel feed and air pressure. Each air zone is controlled by a damper, but if air were now admitted by the control to the zones that are closed off there would be no fuel to burn. The control system, therefore, in order to maintain steam pressure, automatically increases the air pressure under the zones that have been in use, and as the extra fuel is carried over to the fourth zone, a time delay mechanism reduces the air pressure, gives the stoker time to supply sufficient new fuel and then opens the air supply to the fourth zone. This process is then repeated, if necessary, with the fifth zone. The control system is designed to maintain the steam pressure, to vary the air distribution in the zones according

to the load and to prevent air being admitted to the zone until the grate above it is covered with fuel.

For underfeed stokers, one of the stoker manufacturers has devised an automatic system for controlling the amount of air passing to the fuel according to the amount of fuel fed, which varies directly as the load. A system of balanced differential pressure vanes and dampers suitably interconnected, is placed in each tuyere zone. As more fuel is fed and the fuel bed thickness increases, the differential air pressure between the tuyere and the space over the fire increases. This actuates the balanced vanes which, through suitable linkage, move the dampers to admit more air until the proper conditions are restored. Conversely, if the fuel bed becomes thin or porous, the differential pressure will decrease and the pressure vanes will close the dampers.

Several new forms of automatic combustion control equipment transmit their impulses electrically. The control system may be actuated by variations in steam flow, steam pressure, furnace pressure and the like or various combinations of these. Such variations cause the master controller to send out electrical impulses to the elements at the various machines to be controlled and these electric impulses in turn actuate the regulators that control fuel feed, fan speed, dampers and other equipment.

One company has placed on the market this year a gas density regulator designed to maintain proper combustion conditions in furnaces. A diaphragm type of regulator is used, a fan maintaining air pressure on one side of it and another fan maintaining flue gas on the other. As the CO_2 and CO vary in the flue gas, its density will vary and the regulator will be actuated.

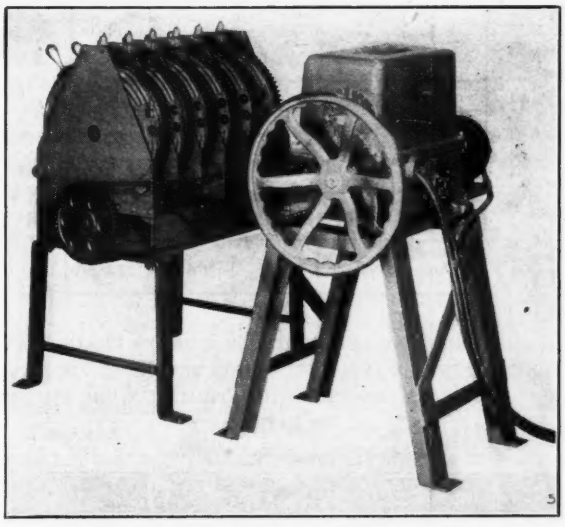


FIG. 2. IMPROVED FORM OF BAILEY CONTROL DRIVE

Manufacturers' Statements

STATEMENT BY BAILEY METER CO., CLEVELAND, OHIO

THE NEWLY developed Bailey control drive is illustrated in Fig. 2. This view shows the drive operating a banked grid rheostat through a sprocket and chain drive with hand wheel and position indicator mounted on the control drive itself. Possible applications of this drive are illustrated by Fig. 3.

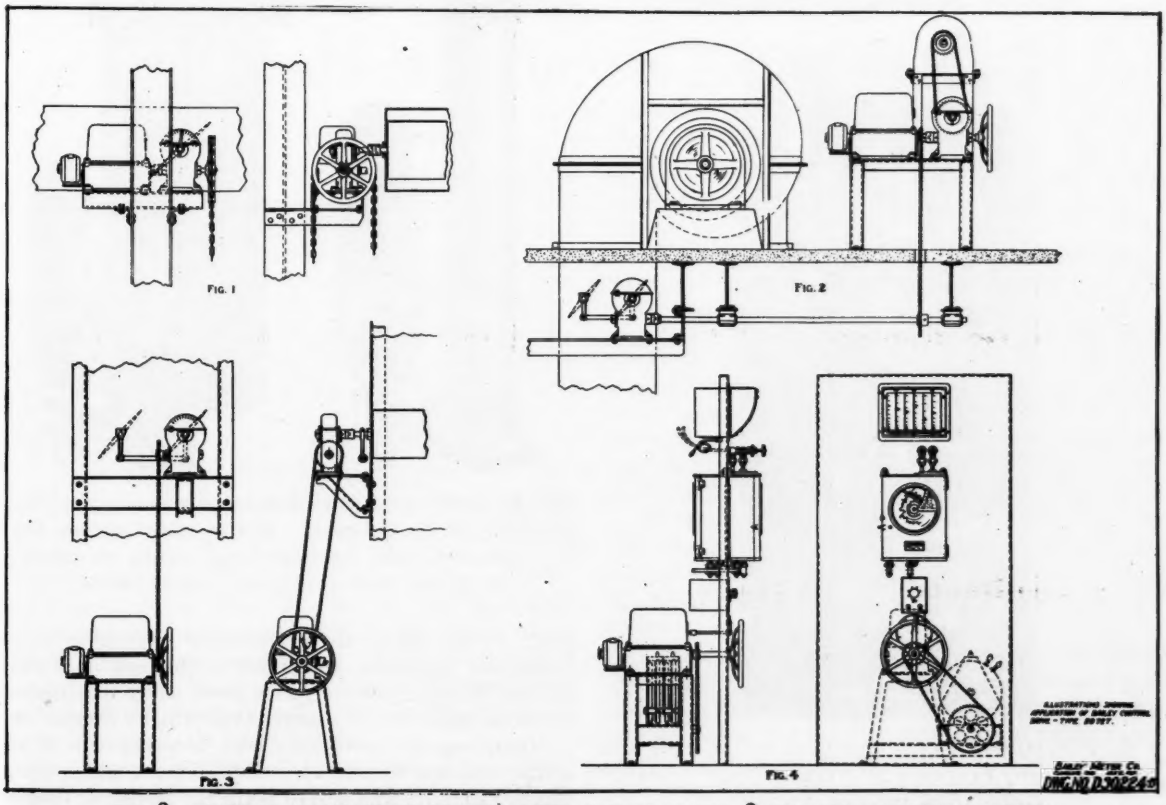


FIG. 3. POSSIBLE APPLICATIONS OF NEW DRIVE SHOWN IN FIG. 2 ON BAILEY CONTROL SYSTEM

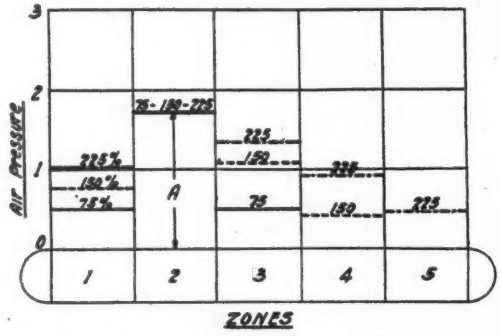


FIG. 4. VARIATIONS OF LENGTH OF FIRE ON CHAIN GRATE STOKER. NEW CONTROL SYSTEM FOR INDIVIDUAL AIR ZONES REGULATES THIS LENGTH AUTOMATICALLY WITH CHANGE OF RATING

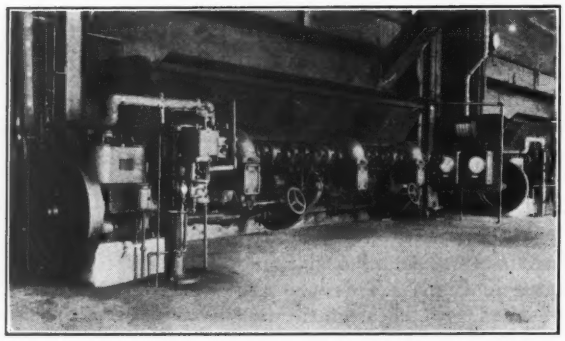


FIG. 5. A MODERN UNDERFEED STOKER INSTALLATION OPERATED ENTIRELY BY AUTOMATIC COMBUSTION CONTROL BUT WITHOUT INDIVIDUAL ZONE CONTROL

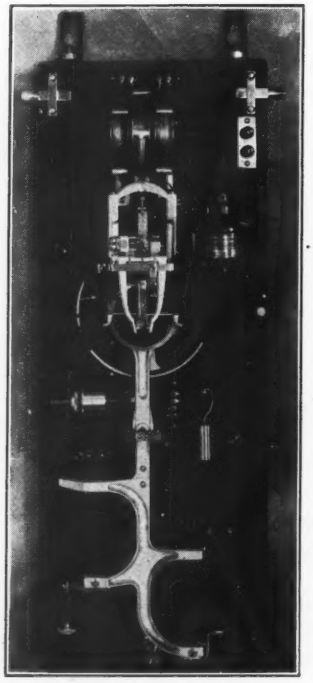


FIG. 6. THIS FLOW BALANCE MEASURES STEAM FLOW AND FORMS IMPORTANT PART OF A NEW ELECTRICALLY OPERATED COMBUSTION CONTROL SYSTEM

A large number of improvements have been incorporated in this new form of control drive, based on experience in the field of automatic control of boiler operation. It has been designed with the points of compactness, accessibility, convenience of location and ruggedness in mind. The fact that this unit can be located right at the element being controlled in a great many cases eliminates considerable connecting shafting and gearing. It is not proposed that this control drive will altogether supplant the larger drives previously

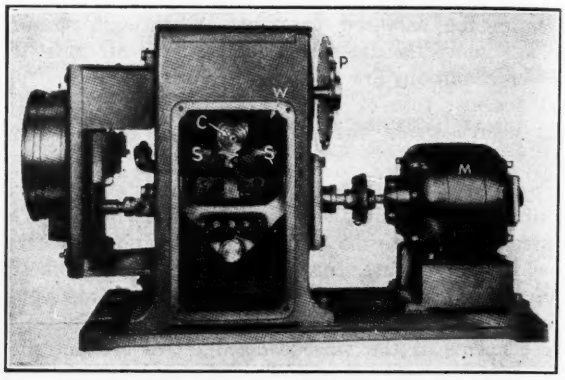


FIG. 7. POWER UNIT OF ANOTHER TYPE OF ELECTRICAL COMBUSTION CONTROL SYSTEM RECENTLY DEVELOPED

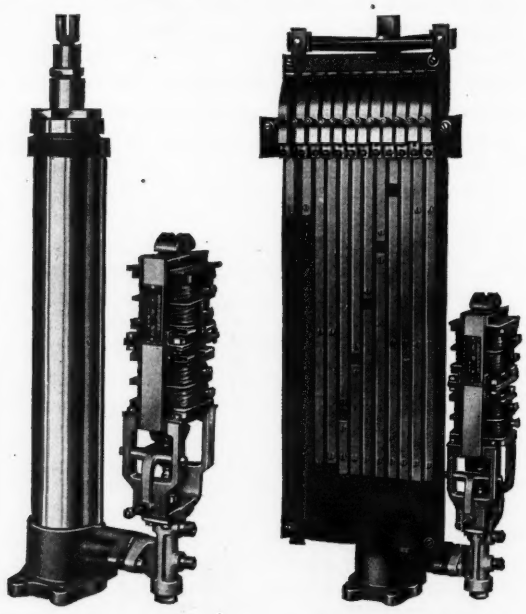


FIG. 8. LEFT—RUGGLES-KLINGEMANN SERVO MOTOR OPERATED BY DOUBLE SOLENOID. RIGHT—SERVO MOTOR, SOLENOID OPERATED AND EQUIPPED WITH TIMING SWITCH FOR SELECTIVE OPERATION FROM MASTER SWITCH

used, as the latter are particularly applicable to installations requiring zero reset mechanism and other special features; however, in a great many installations its advantages over the larger type will be pronounced.

Improvements have also been incorporated in the contact-making devices of Bailey Meter control equipment to simplify and also to refine the system of control.

STATEMENT BY LOCKE REGULATOR CO., SALEM, MASS.

We have a new combustion control regulator which has recently been patented. This regulator has a compensating attachment and is capable of making a full stroke on one-quarter pound fluctuation or 40 lb. fluctuation or at any place between. It is of good mechanical design, is easy of regulation and the price is moderate. All parts are readily accessible. Regulator is turned out with nickel finish and built for all pressures up to 500 lb. This regulator may in turn be used to control pressure reducing valves as a combination pressure regulator.

It has only two wearing parts, either of which may be renewed at low cost. These parts are designed so that they will not be subject to renewal until after five years' use. This regulator is undoubtedly superior to any of our former ones. It has a compensating arrangement or cutoff that has been cleverly designed, making the regulator operate through innumerable steps in completing a stroke.

STATEMENT BY RUGGLES-KLINGEMANN MFG. CO., SALEM, MASS.

Our principal development in boiler control equipment for the year 1927 comprises a line of hydraulically operated servo motors for centralized control of forced draft and uptake dampers and for the control of steam-driven or variable-speed electrically-driven fans and stokers.

These servo motors in their simplest form consist of hydraulic plungers operated by means of solenoid-operated pilot valves, as shown in Fig. 8, left. A double acting solenoid controls the selective operation of the plunger in either direction required, the plunger being held to whatever position it happens to occupy when both solenoids are de-energized. The operation can be from push button or automatically from a pressure contactor.

A further development consists in equipping these servo motors with a timing switch as shown in Fig. 8, right, which permits the plunger to be operated in eight step positions from a master switch, one master switch being used to control as many servo motors as required, all being maintained at a position corresponding to that of the master switch.

The master switch used for the control of these servo motors can be operated manually, or by means of a master regulator, such as commonly used for the control of fan engines and dampers. When operated from a master regulator, a sprocket wheel is provided permitting the use of chain and counter-weight. When operated manually, a hand wheel is provided in place of the sprocket.

In addition to the above control equipment, this company has developed a line of solenoid operated valves for use in the operation of steam driven fans and stokers; also on fuel oil lines where dead open and shut operation is required, either from manual push button control or automatically from the master regulator.

It will be seen that by means of the above equipment, dampers, control valves, and rheostats or any number of such units can all be controlled from one centrally located station, either automatically or manually, and without the necessity for the use of chain shafting or other mechanical connections, and that the relative positions of these various units are maintained for the entire cycle of control.

Feedwater Control Equipment

PRESENT DAY DEMANDS REQUIRE QUICKER RESPONSE FROM FEEDWATER REGULATORS

INCREASING capacity of boilers, increasing ratings and pressures and increasing range of fluctuation of boilers have taxed methods of feedwater regulation to such an extent that methods used only a short time ago are no longer adequate for present demands. The most marked development in feedwater regulation devices has probably been the addition of a sensitive thermostatic regulator which is operated by the flow of the steam and which is auxiliary to the ordinary water level type regulator. Several such devices are described by their manufacturers in the following pages.

REGULATORS MUST RESPOND QUICKLY

Nearly all feedwater regulators possessed the natural tendency to continue to feed a boiler after an increase in pressure occurred or after the load had dropped and generally stopped feeding as soon as there was a sudden load demand. This resulted in a drop in pressure and such regulation is unsuitable under present high pressure service. The regulator must respond more quickly so that as soon as the water level has reached the lowest allowable point in the gage glass, the feed valve should be wide open.

One method designed to accomplish this is based upon the principle that more heat will pass through an orifice in a given time in the form of hot water at steam temperature than in the form of steam at the same temperature. This regulator uses no floats, generators, links or thermostats and has no moving parts. It consists of a simple hollow vessel, Fig. 1, with an inlet, an outlet and a pressure port. There are two orifices which are so proportioned in area that when dry steam passes into the body of the regulator, the pressure within the regulator, compared to the boiler pressure, is relatively low. This pressure differential acts on the diaphragm of the control valve but is not sufficiently heavy to close the valve. Therefore, as long as the water in the boiler is below a slotted entrance to the supply pipe, water is fed into the boiler. Water from the wet steam formed by the spurting water flashes into steam when it enters the regulator and thus increases the pressure and tends to close the feedwater control valve gradually until the rate of feedwater input equals the demand for feedwater.

Float type regulators, which are operated directly by change in water level, have been improved by employing steel castings for float chambers for working pressure up to 750 lb. The feed valve is made to open progressively as the water level in the boiler falls and close progressively as the water level in the boiler rises. A single cover plate obviates the necessity of splitting

the casing or cover plate for the removal of interior parts therefore necessity of breaking steam or water connections in order to remove such parts is avoided.

Manufacturers' Statements

STATEMENT BY NORTHERN EQUIPMENT CO. OF ERIE, PA.

Recently a new type of Copes feedwater regulator has been developed to meet the exacting requirements of large boilers which are operated at high ratings. Installation of this new type regulator on a Ladd boiler of 29,000 sq. ft. and operating at 500 per cent of rating is illustrated in Fig. 2. This new type regulator is controlled by a combination of steam flow and water level movement. As shown, the regulator consists of a double thermostat, with two expansion tubes, each of which actuates the same control valve.

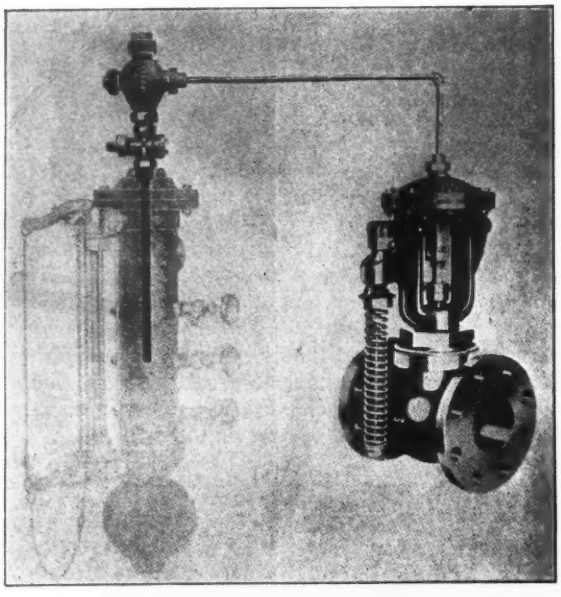


FIG. 1. FEEDWATER REGULATOR FUNCTIONS THROUGH PRESSURE DIFFERENTIAL OBTAINED BY USE OF TWO ORIFICES

It will be noted that the water level in the expansion tube of the vertical thermostat is higher than the water level in the expansion tube of the diagonal thermostat for the reason that, on account of the friction loss through the connecting tubes, the steam pressure in the dry drum, to which the steam connection of the vertical thermostat is made, is less than the pressure in the main steam drum to which the steam connection of the diagonal thermostat is made.

The vertical thermostat is designed to operate the Copes control valve normally, increasing or decreasing the feed, dependent on the flow of steam from the boiler. As the flow of steam from the boiler increases, the drop in pressure between the main boiler drum and the dry steam drum increases. This causes the water in the vertical thermostat to rise. As the level in the vertical thermostat becomes higher, the thermostat contracts and opens the Copes control valve supplying more water to the boiler. As the load decreases, the difference in pressure between the main boiler drum and the dry steam drum is lessened. Consequently, the level in the vertical thermostat lowers and less water is supplied to the boiler.

If for any reason the vertical thermostat does not move the control valve a sufficient distance there will of course be a change in water level in the main drum. This change in water level will affect the level in the diagonal thermostat. This thermostat will, in turn, readjust the valve and compensate for the variation produced by the vertical thermostat. Any adjustment which may be necessary in the water level may be made by the nuts on the top of the vertical thermostat. Tightening the nuts will raise the water level in the boiler gage glass and loosening the nuts will lower the water level.

Improvement in the design of the control valves of the Copes feedwater regulator for high pressures has been incorporated in the outboard ball bearing valve shown in Fig. 3. It will be noted that the lever shaft has a ball bearing supporting the extreme end of the shaft. This prevents any spring of the shaft and also takes care of all end thrust. It provides a deep stuffing-box with sufficient packing to prevent any possible leakage and at the same time does not increase the frictional resistance beyond that encountered in a double stuffing box valve.

STATEMENT BY SMOOT ENGINEERING CORP. OF NEW YORK CITY

Since 1920 boiler room practice underwent radical changes, both as to the sizes which were to be in operation and as to the steaming rates delivered by each unit. Today boilers are operated at ratings varying

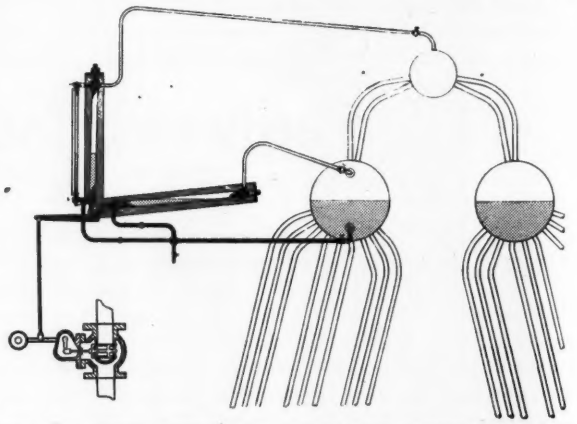


FIG. 2. COPES FEEDWATER REGULATOR COMBINES ACTION OF STEAM FLOW WITH THAT OF WATER LEVEL MOVEMENT

from 100 per cent to 600 per cent and the flow must be varied in the ratio of 1 to 4 in nearly every public utility plant. For these radical changes in quantity of steam produced, the level control alone has proven unsatisfactory.

We have solved this part of the problem by a flow regulator which supplements the inadequacy of the level regulator for large boilers operating under varying rating conditions. This water flow regulator pushes the water into the boiler in the same proportion as the steam leaves the boiler and maintains a safe quantity of water in the boiler at all times.

Our water flow regulator operates on the difference in pressure which must exist to maintain a varying

flow of water through a given pipe system. This excess must vary according to the square root law which governs the flow of all fluids, consequently excess pressure should increase as the square of the rating. By varying the excess pressure in this manner, it is possible to use the usual feedwater level regulators successfully because the excess pressure regulator does the major portion of the regulating while the water level regulator serves as a micrometer adjustment. In any one position, the valve corresponds to a fixed orifice and by varying the pressure across this valve with the square of the rating, the supply of water is made equal to the amount of steam generated. The water level will vary in the glass during radical variations in rating due to the different volumes of steam in the tubes.

It is characteristic of water level regulators operating with a constant excess pressure to carry a lower

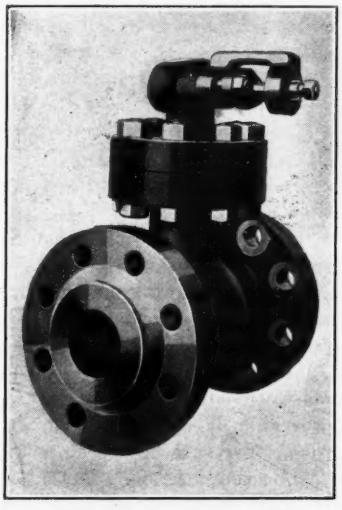


FIG. 3. OUTBOARD BALL BEARING VALVE IMPROVES REGULATOR ACTION

water level with increased rating. This characteristic is eliminated by increasing the excess pressure with the rating whereupon the water level will remain practically constant at all ratings.

There are two general ways to apply the Smoot Control to boiler plants. If the boiler plant has but few boilers, all of the same rating, and the line resistance is not great, it is sufficient to control the excess pressure at the pumps, leaving the water level regulators to take care of any discrepancies in the line resistance. If the plant is composed of a large number of boilers, with groups of boilers operated at different ratings or if there are boilers of different sizes or firing equipment, then it is essential that the excess pressure regulators be individual to the boilers with separate regulators on the pumps, giving an excess pressure variation greater than the maximum boiler excess pressure. In this manner the boilers running at lower ratings will be protected by the individual excess pressure regulator. Such an arrangement is shown in Fig. 4 and Fig. 5 shows how the excess pressure regulation is accomplished.

STATEMENT BY THE SWARTWOUT CO. OF CLEVELAND, O.

The first feedwater regulator, actuated by water level and steam flow, for a large boiler, was installed by the S-C Regulator Mfg. Co. in 1926, before its consolidation with the Swartwout Co. This has been in continuous service for over one year.

During the past year, the development in feedwater regulation has been rather rapid and we have furnished several large stations with feedwater regulator equipment of the continuous feed type and having a special design so as to hold an almost constant water level during all load conditions. The use of excess pressure regulating valve ahead of feedwater regulator has fast

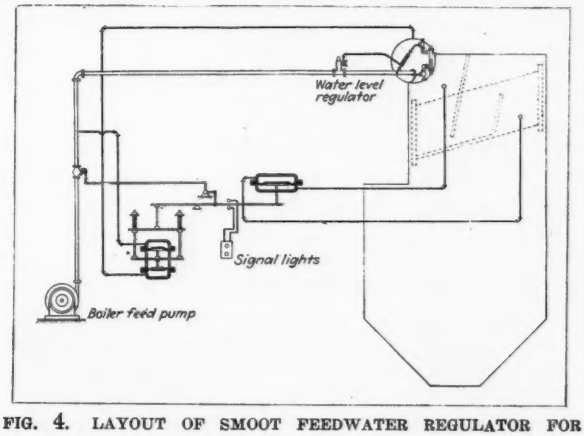


FIG. 4. LAYOUT OF SMOOT FEEDWATER REGULATOR FOR SINGLE BOILER

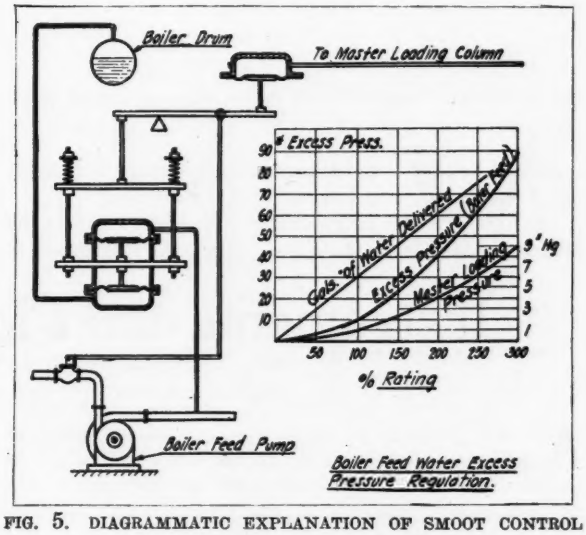


FIG. 5. DIAGRAMMATIC EXPLANATION OF SMOOT CONTROL OF EXCESS FEEDWATER PRESSURE

become standard practice among power plant operators. During the past year, we have developed a differential pressure regulator valve to be used ahead of feedwater regulating valve and so designed that it can be set for a minimum pressure differential, or rather pressure drop to the feedwater regulating valve. This differential valve has an auxiliary mounting actuated by a special generator attached to the boiler drum so that when the rating of the boiler goes up the differential pressure or pressure drop through the regulating valve is increased. This compensates for losses in boiler pipe and fittings on the increased ratings and furthermore tends to allow the boiler to carry an almost constant water level during any load conditions.

This system of regulation may be applied to any type of boiler, one of which is shown for explanation purposes. If the pressure between drums A and B would be exactly the same as that in drum C, then a water level would exist in pipes D and E, at the elevation of valve F. As the rate of operation increases, the pressure drop between drums A and B and C increases and this, lowering the water level in pipe D, exposes the heat

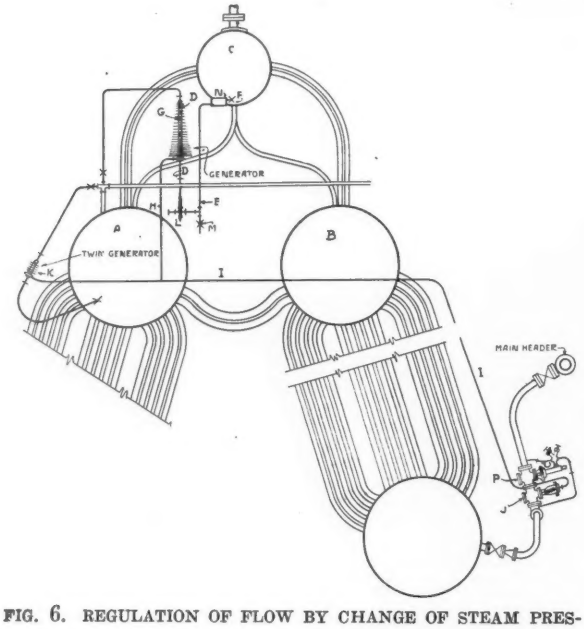


FIG. 6. REGULATION OF FLOW BY CHANGE OF STEAM PRESSURE SUPPLEMENTS THAT DUE TO CHANGE OF WATER LEVEL

from inside pipe of generator A to the water surrounding it and creates a pressure in this generator.

As this pressure in generator G increases due to the lowering water level in pipe D, the generator pressure forces water from generator G down tubing H into tubing I, and this water passes on through tubing I to the diaphragm of regulating valve J, opening it a greater amount than that due to water level line in drums A and B, operating on generator K. As the load increases, or in other words, as the pressure differential between A and B and drum C increases, the amount of water forced out of the generator G increases and the regulating valve J is opened a proportional amount.

The capacity of generators K and G is so proportioned that if the water level would rise in drums A and B, the excess water would go back into generator K and thus allow the regulating valve J to pinch down the rate of feed. At no time can the water level in drums A and B rise above the bottom of generator K without causing the regulator valve J to open wide. The manometer loop layout may be varied so that generator G would start to function at a certain increased load and keep increasing the boiler feed as the load increases and act oppositely when the load decreases.

If piping E is to be blown down the valve L is provided, so that it can be shut off and pipe E blown to valve M. This avoids blowing the cold water out of the pipe D and thus disturbing the operation of the regulator after the blow-down period. A special surge chamber N is inserted as shown so that on decreasing loads, a supply of cooler water is available in pipe N to flow down to pipe E and D and in this way make the operation of auxiliary generator G very fast. A special differential valve P is provided ahead of regulating valve J so as to maintain a constant pressure drop across the feedwater regulator valve J.

Feedwater regulator equipment for boilers up to 1500-lb. operating pressure has been standardized by us. In this connection, the fact is that the first two feedwater regulators operating on boilers carrying 1200 lb. pressure were of the S-C design and manufacture.

Instruments and Flow Meter Equipment

MANY REFINEMENTS MADE DURING THE PAST YEAR INCREASE THE ACCURACY AND APPLICATION OF INSTRUMENTS

AS AN INDEX of operation instruments perform a function which, although small in itself is, nevertheless, one of the important factors responsible for the remarkable advance in the power plant industry during the past few years. Accurate instruments for the measurement of flow, pressure, temperature and electrical quantities are the pilots which guide the designer and operator.

Considering the remarkable degree of development which recording instruments and flow meters have reached, it is natural to expect that many of the developments of the past year are in the nature of refinement. An improved capillary pen arm, a new line of electric flow meters by one company, an improved visible recorder for strip charts, an auxiliary flow meter recording attachment, a recording demand meter for central steam heating service, a new indicating flow meter and a long distance electrically operated thermometer and pressure recorder are some of the changes and improvements made during the past year.

In a particular field each refinement and development is of great importance. Central steam heating plants are faced with almost the same problems as other utilities, that is the question of peak load necessitating large steaming and distributing capacities which are idle a large part of the time. It is to be expected, and is of course only just that in addition to the steam actually used, some charge, based upon the demand of the load should be made. Ordinarily individual rates are based upon measurement of the condensate, and the development of the condensate demand meter, said to be the first and only commercial meter of this kind on the market, is an important advance.

Flow meter developments, because of the wide application of these instruments, are always important. The new indicator mentioned above is handy for testing or temporary service or where it is desirable to have several indicating instruments in multiple, so that results can be followed by several operators at different points.

The operation recorder for use in conjunction with

the flow meter in a paper mill is of decided advantage to the operator in keeping his flow meter records. This attachment can be utilized to record the continuity of operation of any machine or process, so that any undue fluctuations in the steam can be traced at a glance as due either to the machine or to some irregularity in the flow system, thus eliminating one factor and greatly simplifying the analysis.

1200-Lb. Flow Meter Announced

Another company has improved its strip recorder so as to make the record visible a few seconds after the impression has been made, instead of several minutes later as was formerly the case. Another company has taken over an important line of electrically operated flow meters and announced the development of instruments which operate accurately independent of voltage variations from 95 to 125 v. This important development eliminates voltage regulators from their flow meter panels. They have also developed a meter for 1200 lb. operation.

Recording instruments are widely used for all phases of power plant work and centralized panels for instruments of all kinds are becoming more popular each year. For this reason the long distance electric recording thermometer and pressure gages are of interest because they allow the recorder to be placed at any point or on a centralized board while the thermometer or pressure gage element itself is located at the point where the measurement is made. In this respect they are comparable with the electric flow meter which allows great flexibility in the location of recorder, integrator and indicator, independent of the metering element.

FIG. 1. INSTRUMENT BOARD IN A LARGE POWER PLANT SHOWING A LARGE NUMBER OF NEW ELECTRIC FLOW METERS IN COURSE OF ERECTION

Manufacturers' Statements

Statement by Ashton Valve Co., Boston, Mass.

In addition to the regular gage mechanism, there are two essentials necessary in the production of the perfect recording gage; that is, the clock movement and the pen.

Ashton recording gages are made both in the recording and the recording and integrating type, the first having only a recording pen, the second made with an indicating pointer and scale around the periphery of the chart and indicates as well as records the pressure at all times. These charts show graphically the variation and fluctuation of pressure and duration of time of each variation. Charts are graduated with pressure lines and in fractions of an hour and are rotated by a clock movement of superior quality. Ordinarily the chart is made to rotate once in 24 hr.

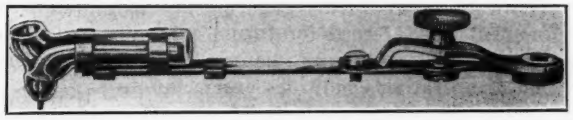


FIG. 2. DETAILS OF THE IMPROVED ASHTON CAPILLARY GLASS PEN, COMPLETE WITH HOLDER ARM AND ADJUSTABLE SCREW

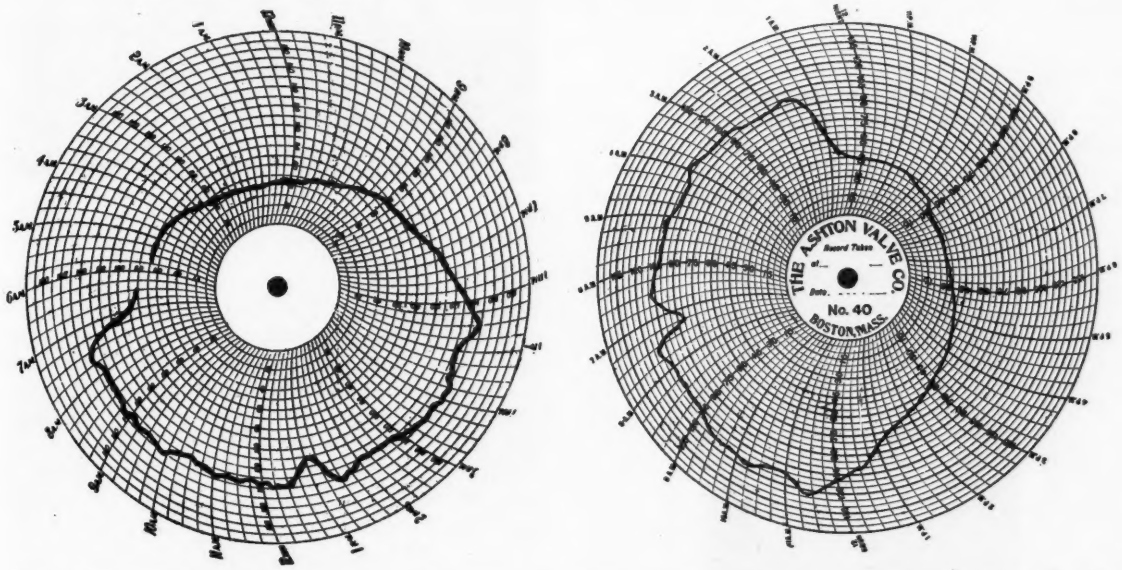


FIG. 3. TWO CHARTS ILLUSTRATING THE IMPROVEMENT IN RECORD MADE POSSIBLE BY THE NEW ASHTON CAPILLARY GLASS PEN. THE ONE ON THE LEFT IS MADE WITH THE OLD STYLE HOD PEN, THAT ON THE RIGHT WITH THE CAPILLARY GLASS PEN

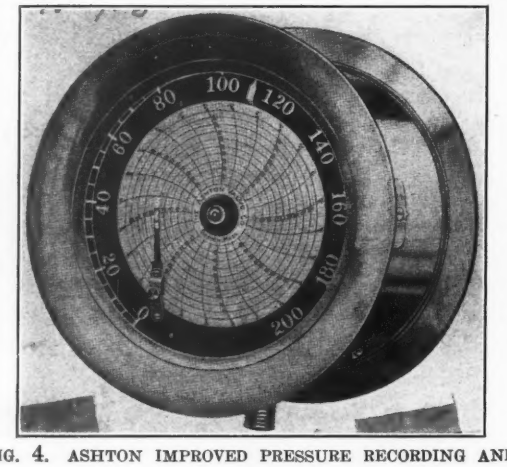


FIG. 4. ASHTON IMPROVED PRESSURE RECORDING AND INDICATING GAGE

and standard charts can be furnished for pressure, vacuum or compound pressure and vacuum.

With the use of this gage officials may obtain a permanent chart record for future reference and comparisons which will assist materially in closer supervision of operating conditions every minute of the day or night. The gage is adapted for steam, water or air service.

New Pen Gives Fine Line

Our latest development is the capillary glass pen shown in the illustration. This pen is of exceptional merit, the design overcoming the trouble experienced with the former gage pens. It is made with platinum points, giving a clear fine line record and is not corrosive. The design is such that it will stand vibration and will not spill ink. It has a large easily filled reservoir which obviates the necessity of frequent filling, and is so fitted to the gage that it can be filled, as well as cleaned without taking apart or detaching from the gage.

The chart shown in the illustration gives an idea of the improved charts obtained with this pen. The chart on the left was made with the old type hod pen, with which recording gages are frequently fitted. The wide abnormal line makes accurate reading impracticable. The chart on the right shows the record line as made with the Ashton capillary glass pen, a fine clear line free from blots.

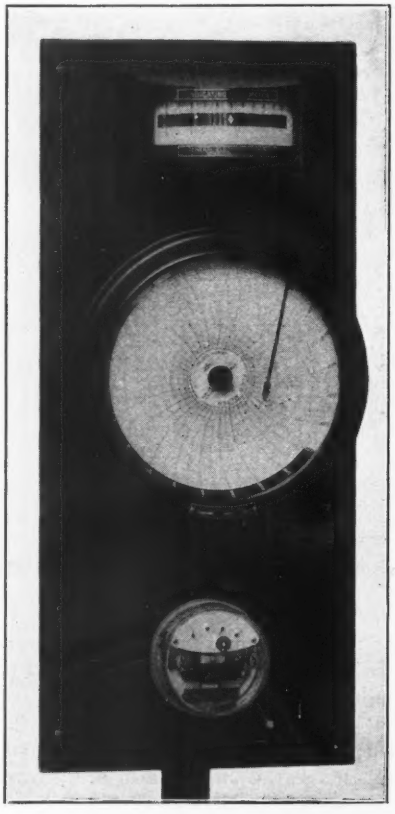


FIG. 5. BAILEY ELECTRICALLY OPERATED RECORDING, INTEGRATING AND INDICATING FLOW METER PANEL

Statement by Bailey Meter Co., Cleveland, Ohio

Keeping pace with the tendency of new power plant progress with high-pressure boilers and turbines, the Bailey Meter Co. has developed a flow mechanism suitable for operation under pressures of 1300 and 1400 lb. per sq. in. gage. Two of these meters have already been furnished and have been in operation for a period of

FIG. 6. TYPICAL INSTALLATION OF BAILEY ELECTRICALLY OPERATED FLOW METER RECORDERS AND INTEGRATORS

three months. Steel forgings are used for the meter elements subjected to operating pressures.

In the past year the Bailey Meter Co. has entered the electric flow meter field and is producing a meter using the transformer principle. These meters of the type known as admittance meters which, due to special design, are not affected by voltage variations and supply circuit between the limits of 95 and 125 v. Bailey electric flow meter units are also suitable for service as liquid level indicators and recorders.

Statement by Brown Instrument Co., Philadelphia, Pa.

In many cases the application of recording instruments requires the closest possible attention to the trend of the facts recorded as shown by the recorder curve. With continuous charts so constructed that a given point in the curve does not become visible for a considerable time after the record was actually made this advantage is lost.

Realizing the need for a continuous chart multiple recorder that would disclose to the user each addition to the record in as short a time as possible after the addition was made, the Brown Instrument Co. set out to satisfy this need.

As a result the Brown multiple record continuous chart recorder is now available that by means of a special ribbon shift provides an unobstructed view of the latest addition to each record line every 15 or 30 sec. An instrument of this type is being developed for recording temperature, percentage of CO_2, speed in r.p.m. or ft. per min. or fluid flow.

STATEMENT BY CENTRAL STATION STEAM CO. OF DETROIT, MICH.

During the past year The Central Station Steam Co., manufacturer of the Cadillac condensation meter, has developed the Cadillac demand meter attachment. This device may be attached to any standard size E, F or G Cadillac condensation meter and provides a continuous 7-day graphic record of the rate of condensate flow to the meter.

The device consists of a special Type G-8 General Electric Co. demand meter mechanically driven by the condensation meter and mounted on a housing attached by brackets to the front of the condensation meter at either side as local conditions may require.

They are particularly useful in checking and analyzing the time and rate of steam consumption, hours of service, etc., and provide a means of measuring the demand element in two-steps or demand steam heating rates.

Size E, F and G meters are rated at 3000, 6500 and 12,000 lb. respectively at a full load speed of 100 r.p.m. Rotation of the condensation meter drum is transmitted by a gear train and link connection to the recording mechanism of the demand meter. The chart of this meter is driven by clock work and the record made by means of a stilus, which is reset by the clock mechanism at regular intervals. These meters can be supplied in 15-min., 30-min. or 60-min. interval reset types, each

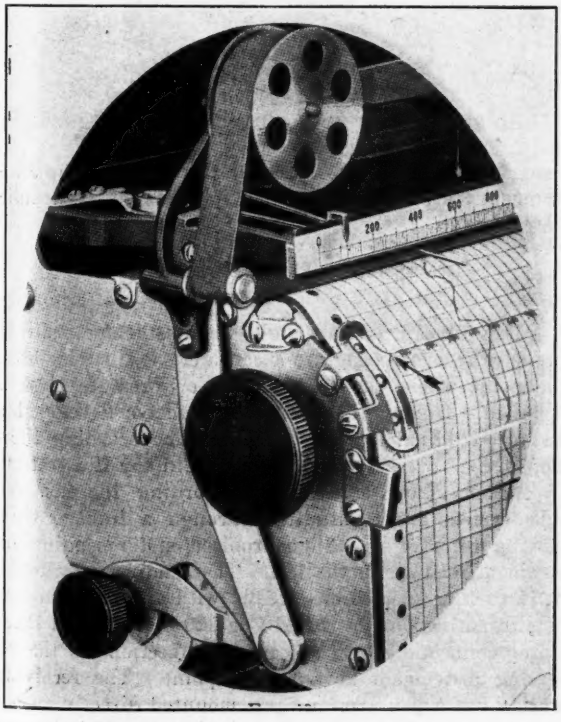


FIG. 7. CLOSE UP VIEW OF THE BROWN VISIBLE RECORDER

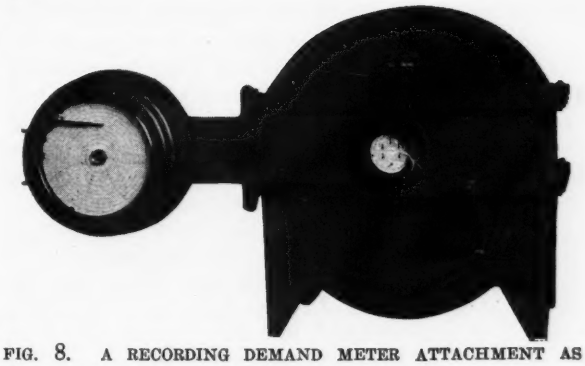


FIG. 8. A RECORDING DEMAND METER ATTACHMENT AS APPLIED TO THE CADILLAC METER

equipped with correct train gear and link connection.

This provides three different sizes of demand meters for various conditions. Any complete assembly may be attached to any one of the three sizes of condensation meters, the difference in capacity and time interval being taken care of by a multiplying factor.

The full load speed of all Cadillac condensation meters is 100 revolutions per hour. When a 60-min. reset demand meter is used, 100 revolutions of the condensation meter drum would advance the stilus 80 steps on the chart. With a 30-min. reset, 50 revolutions of the drum will advance the stilus 80 steps, while with a 15-min. reset, 25 revolutions of the drum will advance the stilus 80 steps, the chart being divided into 100 steps or circle so as to provide for 25 per cent overload registration.

In applying this attachment the counter and counter mounting studs are removed and replaced by a special fitting containing the gear train. The demand meter with special brackets is then attached. The original condensation meter and housing is then reinstalled on the new parts, and continues to function as before. The demand meter attachment does not interfere with the operation or recording of the condensation meter as originally designed and built.

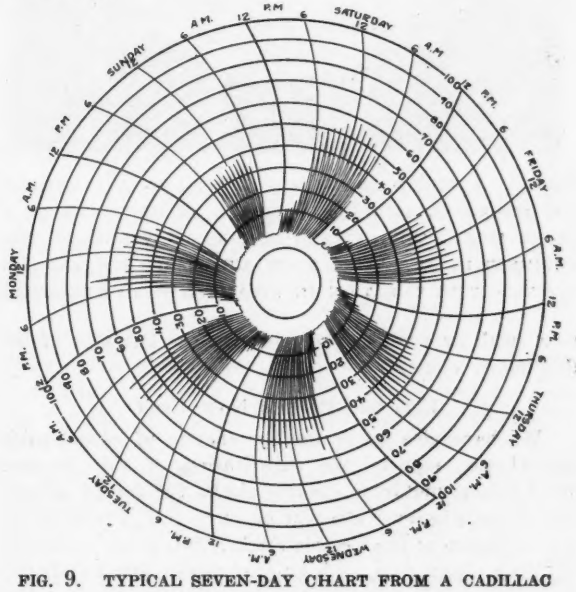


FIG. 9. TYPICAL SEVEN-DAY CHART FROM A CADILLAC DEMAND METER

STATEMENT BY THE COCHRANE CORP., PHILADELPHIA, PA.

During the past year we have perfected an attachment for use with the Cochrane flow meter for recording any occurrence or break in continuity in power plant operation that may be of interest in connection with the flow of fluid being metered. This attachment is shown to the left of the pen arm above Figure Two of the scale in the photograph of the Cochrane flow meter.

The particular instrument illustrated is in service in a paper mill to record paper breaks along with the steam flow. When a break in the paper occurs the rolls in the paper machine, of course, take much less steam which is in turn reflected in reduced steam flow from the boilers. The record of the paper breaks accounts for reduced consumption of steam. Any variation in the steam supply not thus accounted for would have to be explained by irregular operation in other parts of the system. The paper break recorder operates by means of an electrical circuit, which actuates the pen attached

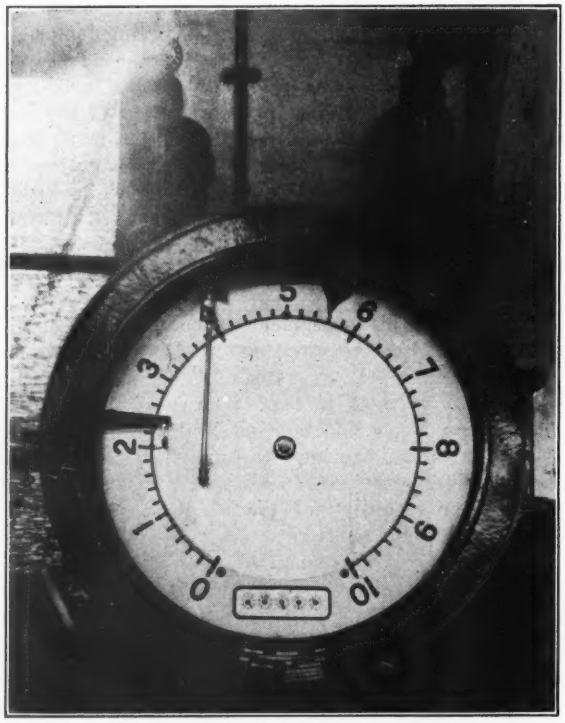


FIG. 10. COCHRANE FLOW METER WITH AN ATTACHMENT FOR RECORDING THE PAPER BREAKS AS INSTALLED IN A PAPER MILL. THIS ATTACHMENT IS OF VALUE TO THE ENGINEER IN ANALYZING FLOW METER RECORDS AND EXPLAINING THE VARIATION IN STEAM FLOW TO THE ROLLS

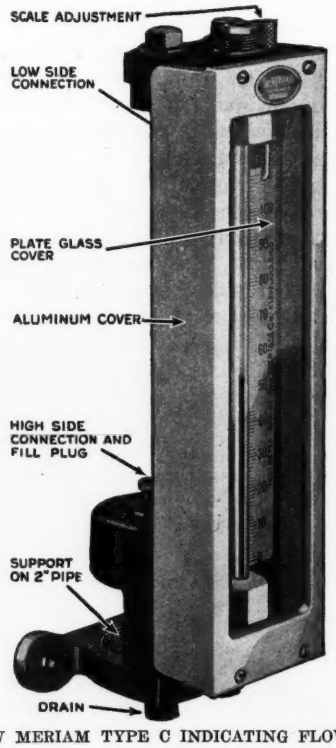
to a small arm which projects over the left side of the flow meter chart.

ELECTRIC CLOCKS NOW USED

We have also made another change of considerable importance, namely the substitution of the Warren synchronous motor or electric clocks for spring actuating clocks whenever alternating current is available for the operation of the electric clock. This saves trouble in winding clocks and, as a rule, provides equal or better time keeping qualities and practically absolute freedom from breakdowns and stoppages to which even the best spring actuated clocks are subject, especially in the dirty, moist, gritty atmosphere of the boiler room.

STATEMENT BY THE MERIAM CO., CLEVELAND, OHIO

RECENTLY a simple, direct-reading, high-pressure indicating flow meter was brought out by the Meriam Company, Cleveland, Ohio. This meter is so designed that it can be assembled in multiple, so that the engineer or production man can see instantly and accurately the horse power or pounds of steam being given off by each separate boiler in the power house.



THE NEW MERIAM TYPE C INDICATING FLOW METER

Using a new packing devised for this purpose, these instruments are now all tested to 2500 lb. hydraulic pressure.

STATEMENT BY THE TAYLOR INSTRUMENT CO., ROCHESTER, N. Y.

Many times it is desirable to install a temperature or pressure recording gage at a considerable distance from the point where the thermometer or pressure gage is installed. During the past year we have developed a distance-reading, electric, transmitting, recording thermometer or pressure gage as shown in the illustration.

Motions from a standard recording thermometer tube system are transmitted through a linkage to a moving rotor of a self-synchronized motor sending instrument, shown on the left. The sending instrument is, in turn, connected electrically with an outside source of alternating current of 110 or 220 v. and with three stator connections and two rotor connections to the receiving instrument at a remote point. The receiving station has a pen arm and pen mounted directly on the rotor of a similar self-synchronized motor and the pen

operates over a revolving chart driven by a clock mechanism.

As the temperature of the bulb fluctuates the coil on the tube system within the case opens or closes, its motion being transmitted to the sending motor, thus revolving the rotor; this rotor, being electrically connected to the rotor of the receiving station, causes the latter to assume the same position as that of the sending instrument.

Installation Is Simple

Installation of the device is simple. The terminals are plainly marked, and it is necessary only to install the sending station near the temperature of which a record is required and insert the bulb so that it is subjected to this temperature, connect electrically to a receiving station located in a convenient and remote position, with provision for connecting the leads to an outside source of alternating current.

The receiving station takes regular Tycos charts and a guaranteed accuracy within one scale division may be expected within the limits of — 40 deg. and + 1000 deg. F. or for pressures of from 0 to a maximum of 25 lb. or to 5000 lb. pressure as desired.

A variation of plus or minus 25 per cent in the applied voltage does not seriously affect the satisfactory operation of this instrument, nor is it affected by the distance between the sending and receiving stations, nor will the proximity of the magnetic field to the connecting wire have any appreciable effect on the operation of the instrument. The device is mechanically simple, powerful and reliable.

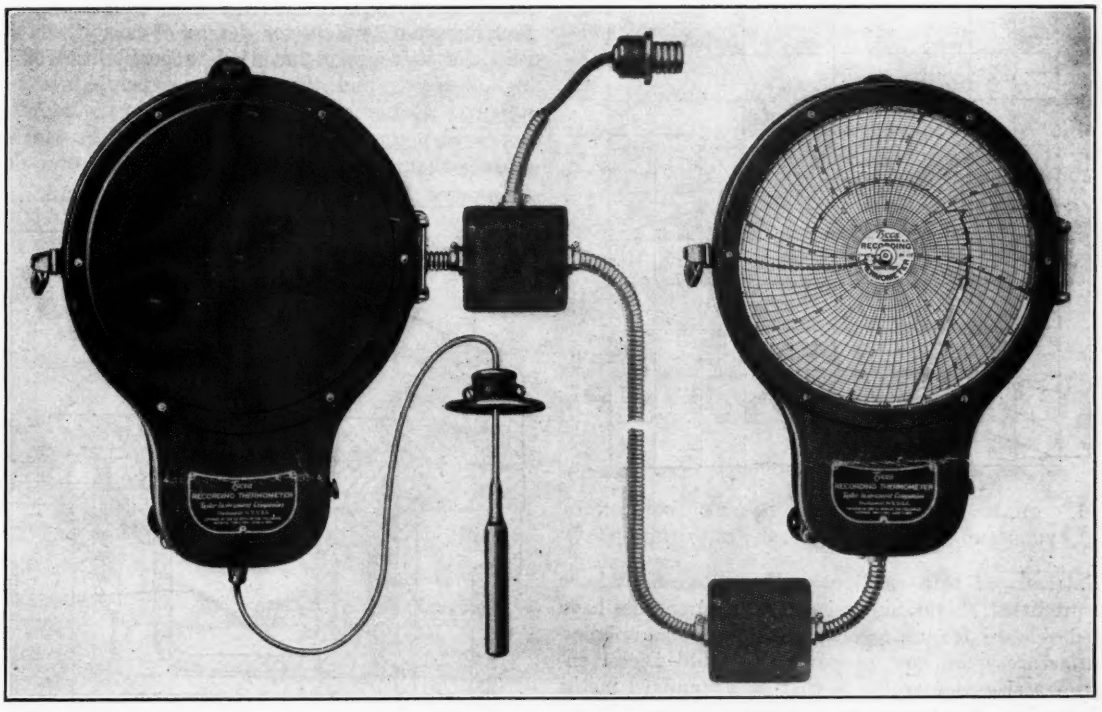


FIG. 11. TYCOS THERMOMETER WITH ELECTRICALLY ACTUATED RECORDING MECHANISM FOR RECORDING FLUCTUATIONS IN TEMPERATURE OR PRESSURE WHEN IT IS NECESSARY OR DESIRABLE TO HAVE THE RECORDING MECHANISM AT A CONSIDERABLE DISTANCE FROM THE INSTRUMENT ITSELF

Do the Sheaves Fit the Rope?

PERHAPS no single element can be more detrimental to wire rope than an improperly fitted sheave. A pinching sheave will do more actual damage to a wire rope in 60 min. of operation than a properly grooved sheave could do in an entire week; or a sheave with too soft a tread will increase abrasion and grinding action to an extent that will cause premature breaking of the outer wires and loss of rope strength. Because of these facts and because sheaves are cheaper than good wire rope, it may be well to look to the sheave and auxiliary equipment, if it is felt that the life and service being received from present rope are not all that they should be.

When installing a new rope, therefore, it is economy to gage both the rope and the grooves of all sheaves and drums. If the groove diameter of any sheave is less than the actual calipered rope diameter sheave replacement should be made, or decreased rope service will result.

Rope diameter	Tolerance of Groove diameter
½ in. and smaller	Plus $\frac{1}{32}$ to plus $\frac{3}{32}$ in.
$\frac{9}{16}$ to 1 in	Plus $\frac{1}{16}$ to plus ⅛ in.
$1\frac{1}{16}$ to 2 in	Plus $\frac{3}{32}$ to plus $\frac{3}{16}$ in.
Over 2 in	Plus ⅛ to plus ¼ in.

One of the simplest methods for gaging sheave treads is by the use of a groove gage, which, if used with care and in accordance with the tolerances given in the table above, will assure satisfactory rope service. While gaging is being done, attention should be paid to alinement.

Oil Engines and Equipment

Improvements Permit Diesel Engines to Emerge from Restricted Field

MANY ENGINEERS, only a few years ago, held the viewpoint that the field of the Diesel engine was rather limited. Each year, however, has seen a broadening of this field until today this efficient prime mover will be found in widely diverse types of service. Recent developments seem to have been most marked in the marine and locomotive branches of service.

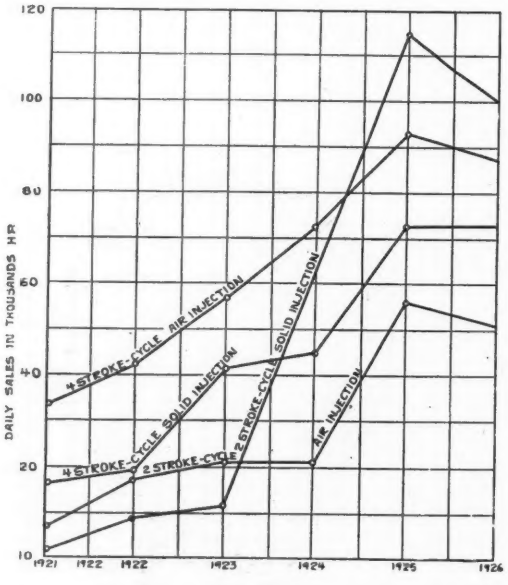


FIG. 1. CHART SHOWING TRENDS IN THE ADOPTION OF CYCLE AND OF METHODS OF FUEL INJECTION

Extremes of both small as well as large sizes have been produced. Light, supercharged Diesel engines have been developed for use as motive power for aeroplanes. Manufacturers are now preparing to build Diesel engines of a size comparable to that of a standard motor truck engine. On the opposite extreme, we find Diesel engines being constructed in record size. Many of these are being applied to marine service but there is a constant increase in the number that are being used in the smaller sized power stations, not only as standby units but for regular service.

Applications of Diesel engines to services in industrial power plants are large and varied. Applications to pumping services represent almost as high a percentage of total applications as those to marine services. Marine and pumping services together represent about one-half of the total application of Diesel power.

The largest units for stationary service yet completed in this country are the 3750-br.hp. Nordberg units installed for standby service in the Miraflores station, Panama Canal. The largest capacity in br.hp. per cylinder built in this country is that of the M. A. N. Diesels built by the Hooven, Owens, Rentschler Co. for the U. S. S. Seminole. Both of the above are of the two-stroke cycle type, the former being single acting and employing an air injection fueling method, while the latter is double acting and uses solid injection of fuel.

Cylinders 33.86 by 59.05 in. are used in the 15,000-br.hp. Diesels built in Germany under the M. A. N. patents. This engine, whose rated speed is 94 r.p.m., has cast-iron cylinder heads held in place by bayonet joints; the two-piece cast-iron cylinder liners are fixed at each end and free to expand toward the center of the cylinders and scavenging ports are located between the upper and lower exhaust ports. The frame members between the cylinders are designed to relieve the cylinder castings of both tensile and compressive stresses.

Improved methods of scavenging, in the case of two-stroke cycle engines; more highly developed methods of fuel injection; and better design of combustion chambers and valve gears have led to possibilities of much higher speeds and this, in turn, operated to reduce weights. Researches, which have led to the adoption of improved materials which are able to withstand higher stresses than were formerly allowed and better design,

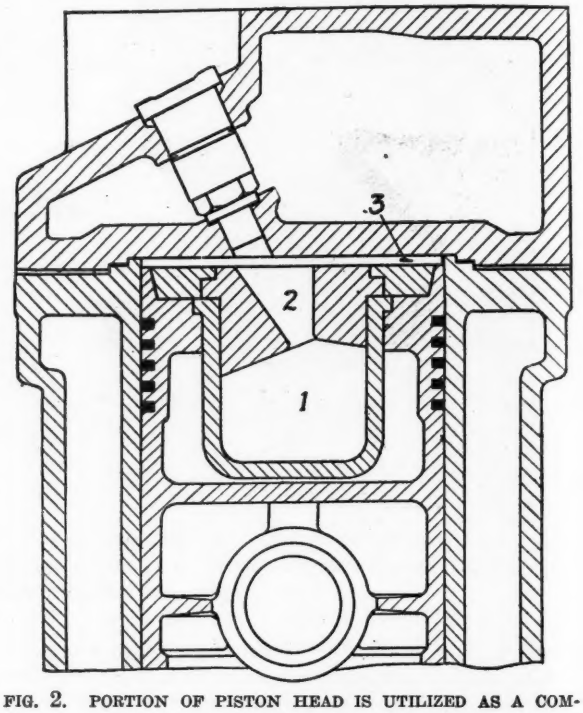


FIG. 2. PORTION OF PISTON HEAD IS UTILIZED AS A COMBUSTION CHAMBER

which has permitted a more rational distribution of such materials, have aided in this trend toward reduced weights.

Complete fuel pump timing control and use of positive displacement scavenging pumps with smoother admission of scavenging air are trends which it is believed will overcome combustion and scavenging troubles. Pre-combustion chambers have been introduced which permit of more complete mixture and more rapid combustion. With the use of pre-combustion chambers it is possible to use larger spray holes, thus avoiding difficulties due to clogging. In a foreign design, a portion

of the piston head is utilized as a combustion chamber. Originally this was intended to be merely a supplementary chamber. In Fig. 2, 1 represents the space in the steel cup; 2, the funnel shaped space in an aluminum plug; and 3, the small clearance space between the piston and the cylinder head. The peculiar shape of the chamber is intended to afford a quick and thorough diffusion of the fuel throughout the entire air space.

Increase of valve port area and of velocity of port opening may be expected to permit increase in speeds.

Fuel pumps compressing oil to a pressure of 10,000 lb. and fuel injection nozzles with spray holes of from 0.007 to 0.020 in. diameter have been introduced in an endeavor to reach higher speeds with good combustion. Light weight pistons of aluminum alloys and tubular forged steel connecting rods have also been introduced with a view to higher speed. The trends toward higher speeds and lighter weights per horsepower are likely to continue for some time, although the rates of change may not be as great as those, at present, indicated.

Another marked trend has been toward the adoption of the two-stroke cycle and of solid injection of fuel for large sized engines, although one manufacturer still builds four-stroke cycle engines exclusively. At present the predominant tendency also appears to be toward the employment of the double-acting principle. The accompanying chart shows the rapid increase in numbers of two-stroke cycle, solid injection Diesels during the

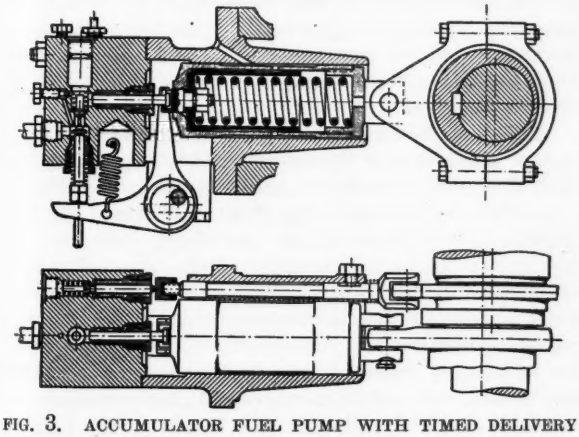


FIG. 3. ACCUMULATOR FUEL PUMP WITH TIMED DELIVERY ELIMINATES INTERDEPENDENCE OF INJECTION FUNCTIONS

period between 1923 and 1925. Increased mechanical efficiency, reduced maintenance expense by refinements in design and increased reliability of operation are outstanding features in recent Diesel engines. Refinements in design have also included improvements in cooling systems in order to reduce internal stresses and distortion, the use of steel tension members to reduce stresses in cast-iron parts of frame and cylinders, and more careful design of bearings and lubricating systems, including a wider use of pressure lubrication. Supercharging, to increase output of a given size cylinder, has been tried but very little information regarding the results is available. Heat exchangers are now used where circulating water of sufficient quantity and quality is not readily available. These exchangers utilize impure cooling water for cooling treated jacket water which is continuously recirculated.

Investigations on oil sprays by Joachin indicate the importance of careful design and arrangement of combustion chamber, valves and piston and the degree, direction and timing of the turbulence they produce on the performance of an engine. It has been found that the compression ratio, the timing and rate of injection, and the promptness and thoroughness with which the oil is atomized and mixed with the cylinder air, control, to a large extent, the lag and speed of both ignition and combustion.

Among the innovations in fuel injection brought out recently is the accumulator pump with timed delivery

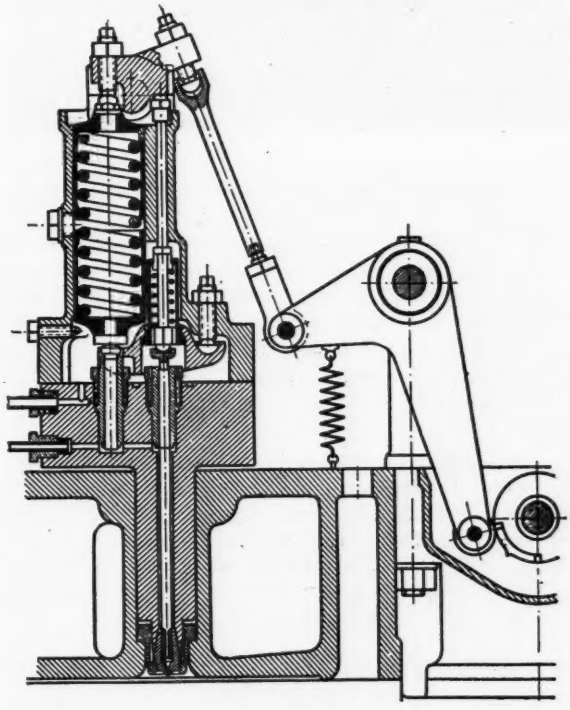


FIG. 4. ACCUMULATOR PROVIDES RAPID NEEDLE CLOSURE

shown in Fig. 3. This is used in airless injection and eliminates interdependence of fuel pressure, duration of injection and engine speed. The pump continuously delivers more than the amount required and provides a supply under pressure from which the amounts needed for injection are tapped off by means of a suitable valve gear. Figure 4 illustrates an improvement on that shown in Fig. 3, whereby the accumulator provides rapid needle closure. One manufacturer makes his fuel injection system as a separate unit supplying it complete with pump and injection valves.

Manufacturers' Statements

STATEMENT BY BOLINDERS COMPANY, INC., OF NEW YORK CITY

Our Type W3, high-speed, lightweight, general utility engines made in one-cylinder sizes rated at 6-7 hp. and two-cylinder sizes at 12-15 hp. are entirely new. They are used in connection with generators, pumps, air compressors and the like in small power plants or for standby purposes in larger plants. These engines operate at a speed of a thousand r.p.m. They are controlled by a

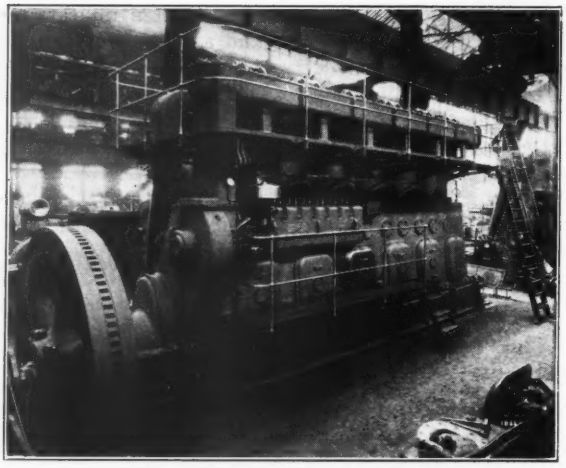


FIG. 5. 1125-BR.HP. SOLID INJECTION DIESEL ENGINE OPERATES WITHOUT WATER-COOLED PISTON HEAD

vertical centrifugal governor driven from the crank shaft by worm and gear running in oil. The governor not only regulates the amount of fuel injected but also controls the distribution of the fuel in the cylinder head thereby regulating the temperature and keeping same uniform at all loads which results in an extraordinarily smooth operating unit giving an exceptionally low fuel consumption.

The crank shaft is mounted on annular ball bearings. The crank pin bearing is of the roller bearing type, and all other bearings with the exception of the wrist pin are ball bearings. These engines are equipped with automatic force feed lubricators and reservoir tank taking care of the surplus oil. We shall gradually develop our larger type engines along the same lines.

STATEMENT BY DE LA VERGNE MACHINE COMPANY OF NEW YORK CITY

Recently we completed the installation of the largest six-cylinder solid injection Diesel engine thus far put in service in this country. It is installed in the plant of the Light and Water Department, Town of Lake Worth, Florida, and is rated 1125-br.hp. at 180 r.p.m.

An interesting feature of this engine is the natural cooling of the piston heads, no oil or water cooling being used. Complicated and often troublesome equipment necessary where the piston heads are artificially cooled are, therefore, eliminated. This feature combined with the extreme simplicity gained by the use of the solid injection principle, efficient design and conservative rating, has resulted in an engine which is rapidly proving its reliability and low operating cost particularly in continuous and heavy-duty operation.

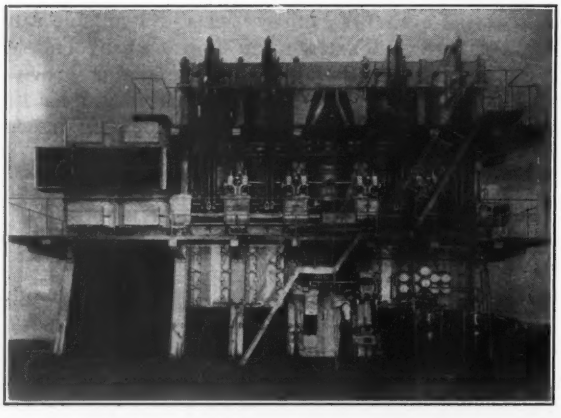


FIG. 6. 3300-HP., 4-CYLINDER, DOUBLE-ACTING, 2-CYCLE DIESEL OIL ENGINE OPERATES AT HIGH SPEED

STATEMENT BY HOOVEN, OWENS, RENTSCHLER CO. OF HAMILTON, OHIO

One of the outstanding Diesel developments of the year, the high-speed, double-acting, two-cycle engine, is the result of the experience at the M. A. N. Company, Augsburg-Nurnberg, Germany. It is now being offered by this company's American licensee, the Hooven, Owens, Rentschler Co., Hamilton, Ohio. This development opens up new opportunities for standby and booster station use, as well as for permanent generating stations. The M. A. N. Company now has under construction two ten-cylindered engines, each developing 11,700 br.hp., a total of 23,400 br.hp., for the Markisches Elktrizitats-Werk, at Hennigadorf bei Berlin.

These engines are of the double-acting, two-cycle type, with M. A. N. patented port-scavenging system. The cylinders are 23½ in. diameter by 36 in. stroke, operating at 215 r.p.m. The scavenging air is supplied by independent driven scavenging blowers. These engines are of the solid-injection type, entirely eliminating the usual attached air compressors. It is interesting to note that this is the first large land installation of solid-injection engines.

This installation marks a distinct advance in Diesel engine application. By operating the engines at the high speed, it is possible to generate great power with a minimum of first cost. The fuel consumption of these engines will be about 0.4 lb. per br.hp. including the power consumed by independent blowers as well as by all auxiliaries, and even using the lighter oil at the greater expense, due to the short time of service, the whole installation will prove highly economical as there are no standby losses. Due to the high speed, the weight per horsepower will not exceed 70 lb.; consequently, the total cost of installation will be practically half of the amount at which Diesel engines heretofore could be bought.

STATEMENT BY STERLING ENGINE CO. OF BUFFALO, N. Y.

It is a significant thing that we have undertaken the building of some exceptionally large gasoline engines at this time, since the general thought toward large in-

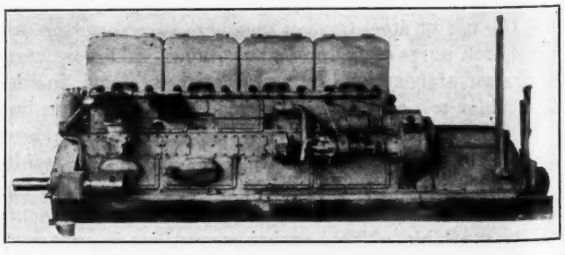


FIG. 7. FORERUNNER OF LARGE SIZED GASOLINE ENGINES CONTEMPLATED TO BE BUILT

ternal combustion contemplates oil engines. There seems to be a lack of effort on the part of the oil companies to improve the distribution of the Diesel fuel oil. Perhaps the explanation is in the fact that this Diesel fuel oil can be converted at minimum expense into gasoline, selling at about 14c a gal. also that a residue which is convertible into by-products is left.

Looking into the future, it is believed that ultimately fuel oil will cost more per gal. than gasoline. A precedent has been established in kerosene which sold a few years ago for 15c a gal. and has been quoted recently as high as 18c.

Thus far, no efforts have been made to apply the gasoline engine to constant duty, they are used only as standby power plants to run at approximately 1200 r.p.m. on gas or gasoline.

Outdoor Switching Equipment

AIR-BREAK SWITCHES, VACUUM-TUBE SYNCHROSCOPE AND LOW-VOLTAGE ENCLOSED BUS STRUCTURE OF PARTICULAR INTEREST

DEVELOPMENT IN OUTDOOR switching equipment during the past year has been mainly in the further refinement of principles and devices which were developed during the past few years. The outdoor substation and outdoor switching station is used almost universally in this country for voltages of 66,000 and over and in many cases for voltages as low as 33,000. The use of outdoor equipment is justified because of the saving in expense for building construction; which would be required if the equipment was housed. When the large amount of space required even for 30,000-v. switchgear is realized, it becomes evident that for higher voltages it is only equipment of the most vital importance that could justify the expense of the enormous building which would be required for their enclosure.

An interesting development in outdoor switching equipment is the so-called air-break switch. This type of switch is an outgrowth of the high-voltage disconnect installed merely to isolate circuits or apparatus. At the present time, however, this type of switch is used by a number of companies to break loads of 1500 kw. at 33,000 v. with considerable success. Experiments with this type of switch on systems operating at 110,000 v. indicate that satisfactory results may be obtained even at this voltage. While switches of this type are in general use, they are not intended to replace the oil circuit breaker, except in the smaller sizes. They are used more for breaking small currents such as charging or exciting currents.

An air-break switch of modern design is shown in Fig. 1. This shows only one phase. For a three-phase circuit three such elements are used, side by side, all operated simultaneously from the same operating mechanism. In some of the earlier types of air-break switches, difficulties were encountered in alining independent poles and contacts, and in making them sufficiently rugged to withstand the severe mechanical shocks to which this equipment is subjected. In the switch shown in Fig. 1 the contacts are self-alining with spring reenforcement. Double-arcing horns are provided at the clip contacts which help materially in dissipating the arc as the arc tends to divide and in effect these are two arcs in multiple so that the amount of current is less than the total that would have to be cared for by single horns. The blades are short which decreases the effort required to operate the switch and also avoids the possibility of the blades getting out of alinement.

Types of air-break switches for high-voltage service vary with the ideas and practices of different manufacturers and engineers. Some engineers have made the claim that the break should take place only in a vertical plane but judging from the number of switches on the market in which the break is in a horizontal plane this

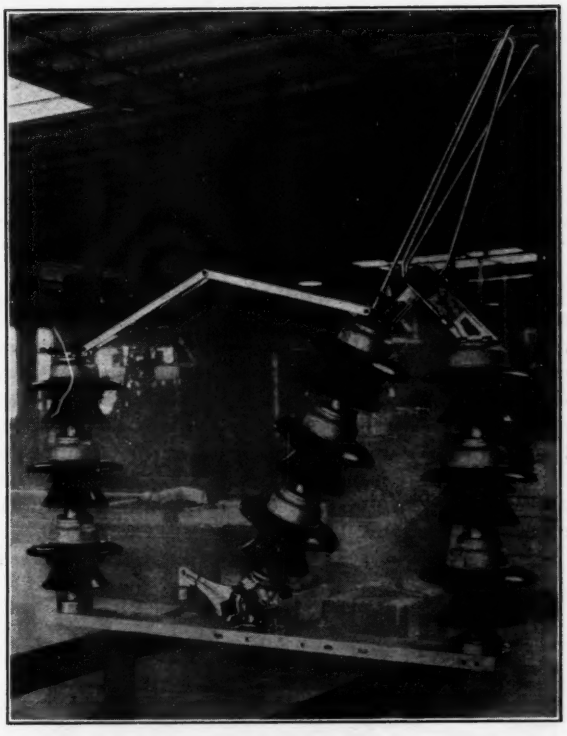


FIG. 1. A TYPICAL HIGH-VOLTAGE, AIR-BREAK SWITCH OF MODERN DESIGN

requirement can well be questioned. It has also been claimed that the break should be as rapid as possible but at least one manufacturer does not agree to this. He claims that air-break switches should not be operated too quickly nor too slowly and that generally speaking with a switch controlled by a motor mechanism, a switch that can be operated in about 36 cycles from the time the motor circuit is energized until the horn gap switch is in the full open position.

Notwithstanding the limitations of the high-voltage air-break switch in breaking power loads, it is believed that it has a definite place in the electrical system and its use will increase. Manufacturers are steadily making improvements and as the performance of switches in service is studied further improvement may be expected.

FIG. 2. NEW OUTDOOR SWITCHHOUSE PANEL EQUIPMENT WITH DEAD FRONT PANEL

Aside from development in air-break switching equipment improvement in other outdoor switching apparatus has been more in the direction of increased standardization and larger units. The General Electric Co. reports a new line of standard outdoor station equipment for capacities up to 73,000 v. Standardized structures, available in two sizes from which 93 different combustions can be made. Delta Star also reports the development of a line of medium capacity standardized outdoor substations made for voltage up to 66,000.

In the transformer field, there has been an increasing tendency toward the use of tap changing under load equipment, and as reported in the December 15 number of Power Plant Engineering a number of large units for outdoor use having tap changes were built. One company reports the construction of a 33,333-kv.a., single-phase unit with the tap changer in a separate pent house. The voltage will be 220,000 star to 69,000 star to 13,200 delta. The height of the high-voltage bushing is 31 ft.

An interesting development in outdoor electrical equipment, is a new outdoor switchhouse equipment for use on systems supplying small power and lighting customers more or less remotely located and where an outdoor substation from the standpoint of cost would be out of the question. This switchhouse, shown in Fig. 2, has a dead front panel, entirely housed in a weatherproof housing, with the meters and relays mounted on steel. The circuit breaker control relay is mounted in a glass case thus removing all dangers of contact with live parts in front of the house. This enables the central station to utilize the services of a more or less inexperienced man to obtain meter readings without danger of physical injury from contact with live parts.

A development which although not primarily outdoor apparatus but which is somewhat related to outdoor switching and substation equipment, is the vacuum-tube synchroscope which made its appearance this year. This equipment does away with the necessity of using expensive potential transformers, using instead a simple oil-filled bushing with a capacitance transformer together with a vacuum-tube amplifier for amplifying the potential. The potential obtained from the capacitance transformer is impressed on the grid filament circuit of a vacuum tube and amplified. This tube should not be more than 50 ft. from the transformer so this low-powered amplifier is built into a weatherproof housing for outdoor mounting. One such amplifier is required for each line to be synchronized. The low-powered outdoor amplifier requires a five-wire, multi-conductor cable between the amplifier and the substation where the

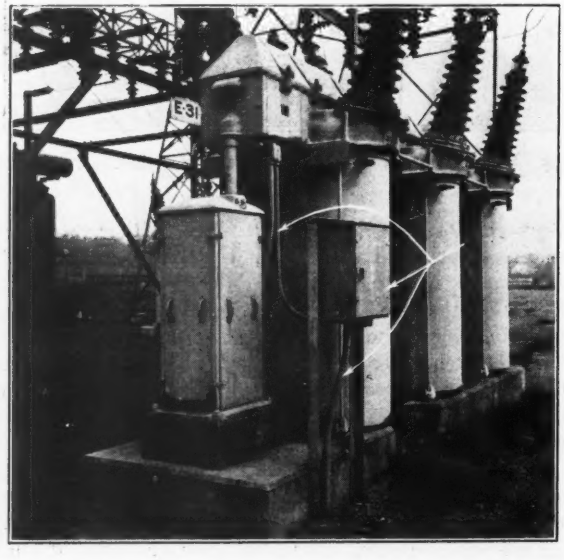


FIG. 3. VACUUM-TUBE SYNCHROSCOPE. ARROW INDICATES OUTSIDE UNITS AND LEADS

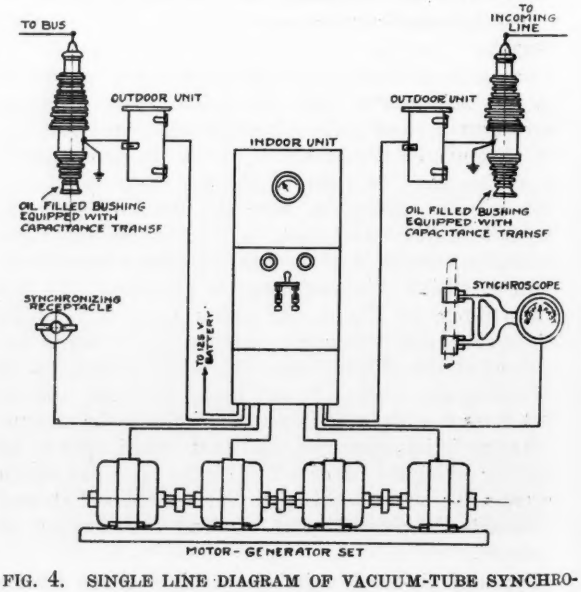


FIG. 4. SINGLE LINE DIAGRAM OF VACUUM-TUBE SYNCHROSCOPE EQUIPMENT

high-power amplifiers are installed. Station equipment consists of a tube and control unit, a motor-generator set to supply current and potential to the tubes, and the synchroscope. The tubes and control unit consists of two 50-watt amplifying tubes and their associated equipment. These tubes amplify the energy from the low-powered amplifiers sufficiently to operate the indicating synchroscope. The tubes and control unit consists of two 50-watt amplifying tubes and their associated equipment. These tubes amplify the energy from the low-powered amplifiers sufficiently to operate the indicating synchroscope. A view of an outdoor vacuum-tube synchroscope installation is shown in Fig. 3. The arrows indicate the outdoor units and leads. In Fig. 4 is shown a single line diagram of the complete equipment.

Oil circuit breakers for outdoor use were subject to further refinement throughout the year and increase in size. The oil circuit breaker is still the main device for opening heavy-power circuits and with the concentration of more and more energy in interconnected systems the task required of the oil circuit breaker is becoming more severe each year. Notwithstanding the increased opening requirements, circuit breaker manufacturers have been able to meet them with considerable success. During the year a breaker of 2½ million kv.a. rupturing capacity for 220,000-v. service was built. While high capacity circuit breakers are available the circuit breaker is still the weak point in the high energy system and development work in every branch of the art is being pursued. Recent experiments by Prof. Sorenson of the California Institute of Technology with a vacuum switch indicate interesting possibilities. With this type of switch, even with currents of considerable magnitude, contrary to expectations there was no pitting, and the circuit was interrupted at the first half cycle. While sufficient definite data on this type of switch to predict anything definite is lacking, it is not unlikely that such a switch will ultimately prove practical.

A further interesting development in outdoor equipment is an installation of steel cabinet switching apparatus for 12,000-v. service, out of doors. In this, the

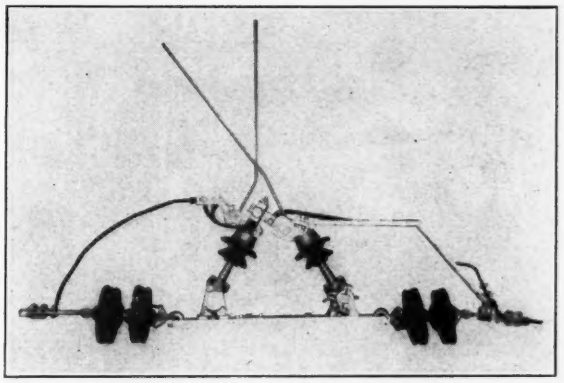


FIG. 5. SINGLE-POLE UNIT OF A TRIPLE-POLE GROUP OPERATED HORN GAP SWITCH. 15 KV., 400 AMP.

12,000-v. buses, disconnects and breakers are all enclosed in a weatherproof structure with the phases 50 ft. apart. This is interesting because it shows how evolution proceeds in cycles. We started out with indoor electrical equipment. Then as the voltages increased and the equipment became larger, outdoor equipment was developed which could successfully withstand exposure to the elements. Now, as the technique of outdoor construction has become standard, this new low-voltage, outdoor equipment makes its appearance, not as strictly outdoor apparatus but adapted for outdoor installation by the use of suitable steel enclosures. If the steel enclosure is considered as a building, it will be seen that we have returned to the indoor type of construction with a modified form of building; however, this is a logical development and its adoption should save considerable expense in building costs.

Manufacturers' Statements

STATEMENT BY CONDIT ELECTRICAL MFG. CORP., BOSTON, MASS.

AMONG THE new developments in outdoor switching equipment made by this company during the year, the manually-operated pole, top oil circuit breaker, shown in Fig. 7, is of particular interest. This breaker, known as

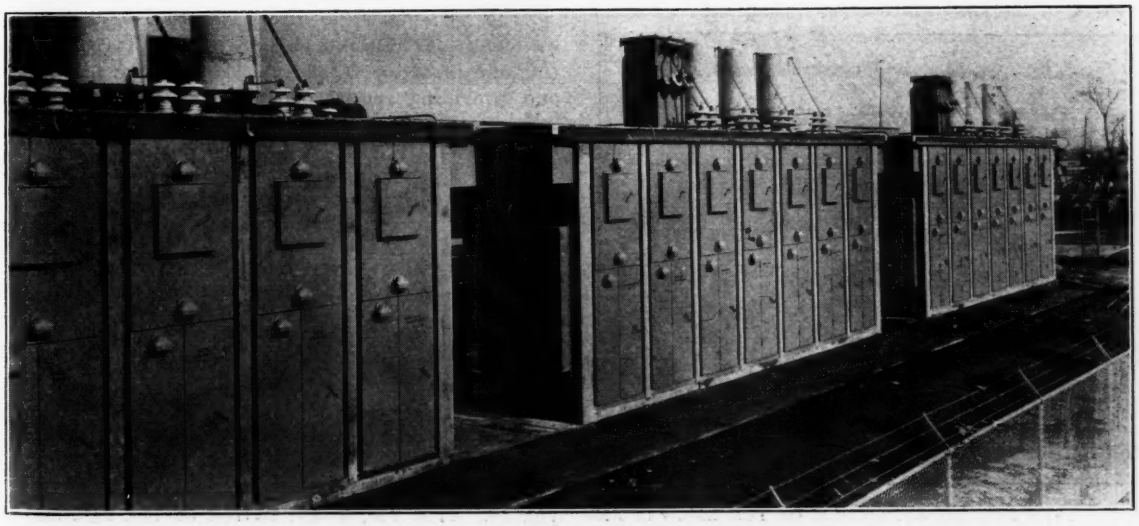


FIG. 6. STEEL CABINET OUTDOOR SWITCHING EQUIPMENT AT NORTHWEST STATION, CHICAGO

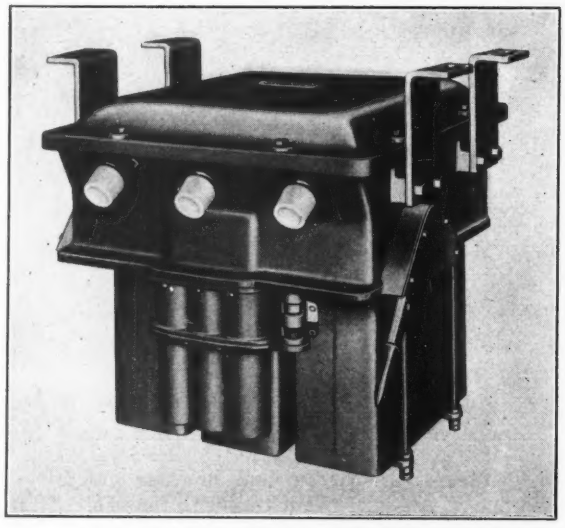


FIG. 7. MANUALLY OPERATED POLE TYPE OIL CIRCUIT BREAKER OF THE CONDIT ELECTRICAL MFG. CORP.

the Type PK-9, is especially designed for outdoor distribution for all voltages, up to 1500.

This breaker is of sturdy construction throughout. The top casting which houses the mechanism and supports the stationary current carrying members with their insulators is designed with its sides sloping inward. This feature of the design making it possible to mount the bushings in such a manner that rain and moisture will drain off external to the breaker and, in addition, will provide facilities for the usual drip loops on incoming and outgoing leads.

The tanks are of strong rectangular construction supported by a strong bolt construction and protected by the overhanging of the top castings. The breaker is furnished for automatic or non-automatic operation. For automatic operation, a bushing type current transformer and a trip coil per pole is furnished. A position indicator external to the breaker is provided so as to determine whether the breaker is in the open or closed position.

The breaker is furnished 1, 2 and 3 pole for 400, 600 and 800 amp. capacity at 7600 v. with an estimated interrupting capacity of 3000 amp. at 7600 v.

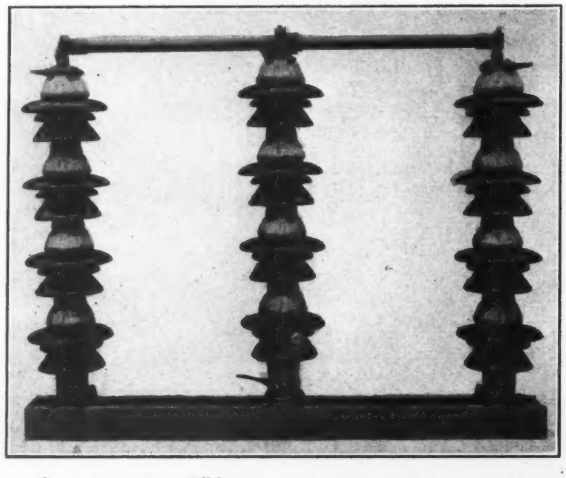


FIG. 9. TYPE TTT, 154-KV. SWITCH OF THE RAILWAY AND INDUSTRIAL ENGINEERING CO.

STATEMENT BY THE DELTA STAR ELECTRIC CO., CHICAGO, ILL.

Considerable progress has been made during the year in the standardization of medium capacity outdoor substation equipment, and several new lines were developed. In Fig. 11 is a photograph of a standardized outdoor substation installation, designed for industrial or town service. It is designed for use on ring systems, permitting service in either direction and is made for all voltages up to 66,000.

Other recent developments are shown in Figs. 11, 12 and 13. Figure 12 is a double-break-per phase switch the center insulator stack of which rotates. This is a special element of a three-pole switch, each element insures a high-rupturing capacity. The contacts are of the floating self-aligning type and are protected by sleet shields thus preventing ice formation interfering with the operation of the switches. Figure 13 is one of our new developments in vertical break pole tap switches for line and outdoor substation service and is made for all standard voltages from 15,000 to 66,000 v. inclusive. The double-acting blade enables the switch to be operated under severe winter conditions as this blade movement effectively shatters ice deposits. It is made for either hand or motor operation all poles of a multi-pole unit simultaneously opening and closing.

In addition to those developments listed other improvements were made in outdoor switch design. One development of particular interest is a 220,000-v. switch in which the blades first rise and then turn horizontally.

STATEMENT BY THE GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

One of the developments in the field of outdoor switching equipment made during the year was a new line of standard outdoor station equipment for capacities up to 73 kv. These equipments are specially adapted for the step-down stations of industrial plants and small towns. The standardized structures are available in two sizes from which 93 different combinations can be made.

The horn-gap type of switch, Fig. 5, utilized for sectionalizing transmission lines was improved by omitting the insulator formerly located at the hinge point and providing special clamping devices for attaching

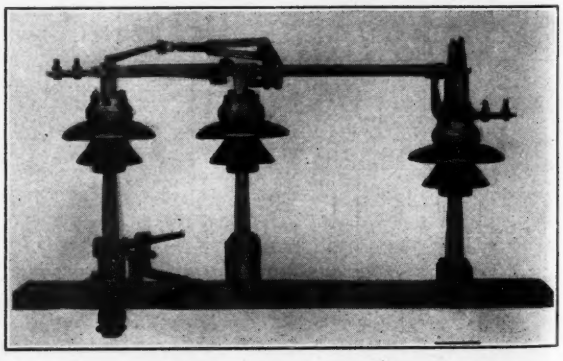


FIG. 10. TYPE TTR, 37-KV. SWITCH OF THE RAILWAY AND INDUSTRIAL ENGINEERING CO.

the pantograph to the strain clamp used to fasten the line to strain insulators. This results in a short base which is suitable for cross-arm mounting and reduces both the weight of the switch and the space required for mounting it. The ratings of this switch range from 400 to 600 amp. for operation on 15 to 73-kv. lines.

STATEMENT BY THE RAILWAY AND INDUSTRIAL ENGINEERING CO., GREENSBURG, PA.

In the past year the Railway and Industrial Engineering Co. has added to their line, two new types of outdoor gang operated switches, embodying the "Hi-Pressure" contact features. These switches are known as types "TTR" and "TTT."

The Type "TTR" is a vertical opening switch and is made for both gang operated disconnecting switch

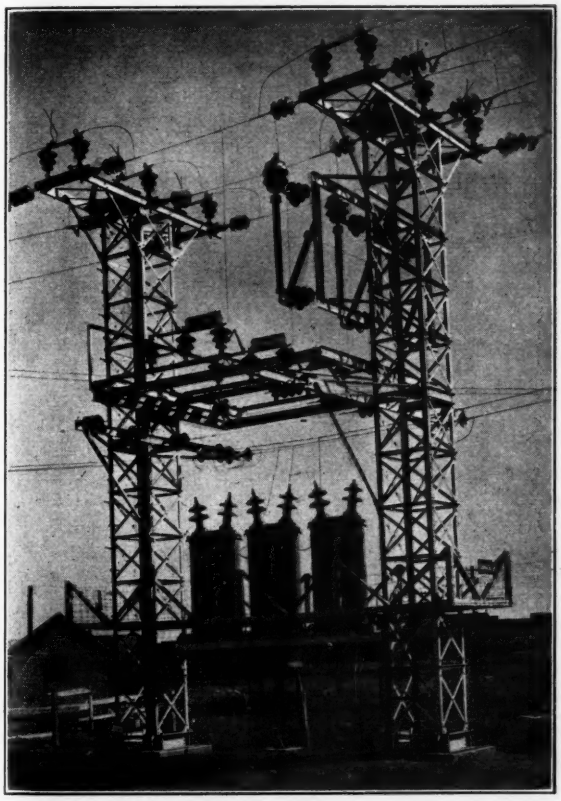


FIG. 11. ONE OF THE NEW MEDIUM CAPACITY OUTDOOR SUBSTATIONS DEVELOPED BY THE DELTA STAR ELECTRIC CO.

service and air-break service. It can be mounted in the upright, inverted or vertical position and is built for voltages from 7500 to 220,000.

The Type "TTT" switch is made for disconnecting purposes only, being a horizontal opening type in either double break—three insulator columns per pole, or single break using two insulator columns per pole, upright or inverted mounting.

Both of the above types of switches are now in service for voltages up to and including 220,000 v. One of the many advantages of "Hi-Pressure" contact is that as the blade is rolled or rotated into the contact, all corrosion, oxides, etc., are removed, thus giving a bright, clean contact surface with every complete operation of the switch. Pressure does the cleaning and pressure makes the contact.

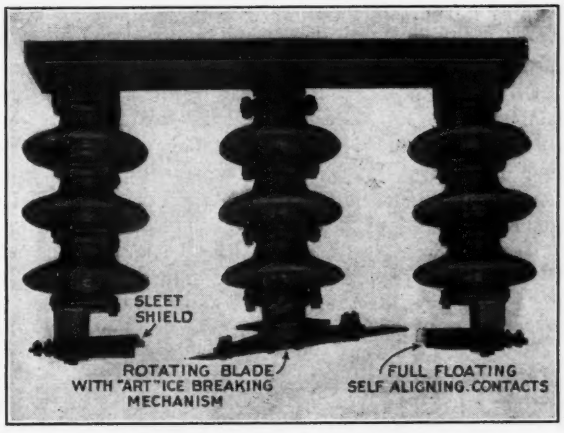


FIG. 12. DOUBLE BREAK PER PHASE SWITCH

With this design many troublesome parts are eliminated and the operating mechanism is extremely simple. It is not necessary to protect the "Hi-Pressure" contact with sleet or rain hoods. On the switches using insulator units in stacks, adjustable spacers are supplied on the columns to take care of structure sag or uneven stresses. Timken bearings support the movable insulator columns. All parts above the insulators are nonferrous, including bolts.

STATEMENT BY THE WESTINGHOUSE ELECTRIC AND MFG. CO., EAST PITTSBURGH, PA.

One of the most interesting developments in the field of outdoor switching equipment is the steel cabinet outdoor switching installation at the Northwest Station extension in Chicago. This equipment, shown in Fig. 6, consists of the 12,000-v. buses and disconnects and the oil circuit breakers enclosed in weatherproof steel compartments. The buses and disconnects inside the upper doors and inside the lower doors are the oil circuit breakers on wheels.

A number of large circuit breakers have been made during the year, the largest being a 2½ million-kv.a. breaker for use on 220,000 v. This is one of the largest breakers ever built. A 2½ million-kv.a. unit for use on 15,000-v. service was also constructed. The latter

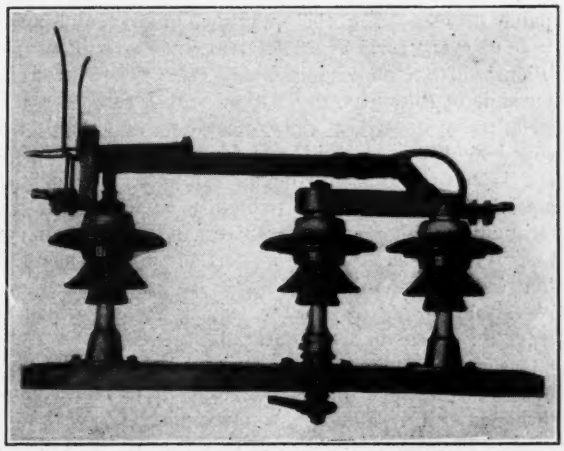


FIG. 13. VERTICAL BREAK POLE TOP SWITCH

contains no porcelain as it is not thought suitable for the tremendous thermal and mechanical effects that must be provided for.

Oil circuit breakers like lightning arresters are unusual among electrical equipment in that they are expected to handle emergencies far outside of the ordinary scope of service. With local circumstances, too, in both cases this emergency duty varies widely in severity. In both cases, it is very difficult to simulate in the shop the severest possible duty that may be met. Consider the question of test facilities up to limit of a two-and-a half-million-kv.a. breaker.

The oil breaker is the main reliance for opening high-voltage, heavy-power circuits. The progress of "super-power" systems and interconnection thus means correspondingly more severe circuit-breaker requirements. The problems are not merely those of increasing size—high-speed action of massive contacts means very large driving forces. It takes an incredible push to shove contacts closed in the teeth of such high-capacity, short circuits as are sometimes found. In opening, the action of the arc, the oil, the gas, takes place in a fraction of a second where it cannot be seen, but it must be correctly known if the breaker is to function. Despite all these difficulties, breakers grow steadily larger and more reliable.

Indicating and Recording Electric Meters

IN ADDITION TO THE DEVELOPMENT OF SEVERAL NEW TYPES OF METERS IMPROVED TESTING EQUIPMENT HAS BEEN DEVISED

IN THE GENERATION and distribution of electrical energy electric meters occupy an important position since it is by their use that all knowledge of the amount of power generated and distributed is obtained. Since the first simple types of tangent galvanometer and the crude although effective, chemical meters devised by Edison, electric meters have undergone tremendous development. Today instruments are available which are capable of measuring the quantity, quality and magnitude of every form of electric current from those of a millionth of an ampere to block energy measured in thousands of kilowatts.

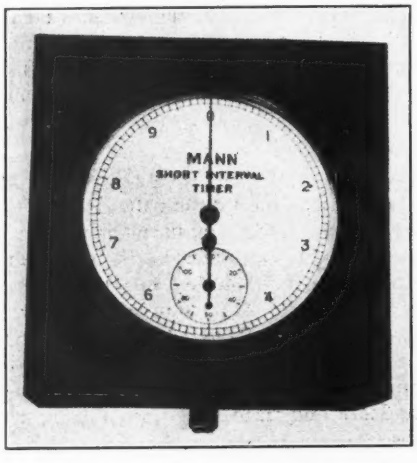


FIG. 1. MANN SHORT INTERVAL TIMER

Naturally in such a highly-necessary and highly-developed field, a great amount of research and development is constantly going on and in spite of the high state of development, new principles and methods are continually being adopted. During the year a number of new type of meters have made their appearance and others have undergone further refinement. New methods have also been developed for testing meters which is always an important consideration.

One manufacturer reports the development of a new house type watthour meter which combines marked improvements in overload performance with refinements in mechanical design. With this meter loads of 400 per cent normal can be metered with good accuracy.

Another manufacturer reports the expansion of their line of single-phase watthour meters so that new two-wire meters in 25, 50 and 75-amp. capacities and three-wire meters in 25 and 50-amp. capacities are available.

This same company also brought out a new reactive volt-ampere meter which can be used on either single or polyphase circuits. The design of this meter is such that no special transformers, compensators or condensers are necessary to displace the voltage impressed on the shunt (potential) coils. The electromagnet series and shunt fluxes are given phase relations such that the other meter registers the reactive component of the load (that is, in proportion to the size of the angle of phase displacement).

An interesting instrument recently placed on the market is a three-phase recording voltmeter. This includes three recording voltmeter movements mounted side by side which offers a convenient arrangement for obtaining continuous and simultaneous records of a three-phase circuit. A single instrument or even two would not give a true comparison, as readings would necessarily have to be taken on different days and with probable varying load conditions. In the new instrument the three recording voltmeters are placed in one cabinet each of which is connected to one of the 3 phases of a 3-phase circuit. The entire instrument is very light in weight and is easily carried by one person.

For measuring resistance in electric circuits two interesting meters were brought out during the year, one capable of making resistance measurements up to 10,000 ohms and the other to 50,000 ohms. Both of these instruments give direct readings. The first, called a circuit tester consists of a small high-grade d'Arsonval type d.c. voltmeter connected in series with a small dry cell. When the instrument is connected to the two ends of an electric circuit, the pointer will indicate the resistance. The higher the resistance of the circuit under test the lower the scale reading will be. Inductance or capacity in the circuit have no effect on the readings.

The other instrument referred to is a type of slide wire ohmmeter adapted to the rapid measurement of coils and resistance units on a quantity production basis. By means of a plug and four sockets, the instrument will measure any resistance between 0.5 and 50,000

ohms. The use of the meter varies slightly from that of the one just described. Instead of a direct reading scale, this meter is provided with a galvanometer and graduated dial. When the meter is properly connected, the dial is rotated until a balance is obtained on the galvanometer. The resistance is then read directly from the dial. Two small flashlight cells, for furnishing the necessary e.m.f. are contained in the base.

When testing and calibrating meters, it is important that the time factor be of the same order of accuracy as the energy measurement. The common use of induction type relays has also produced a need for accurate short-interval timing devices. To avoid the personal

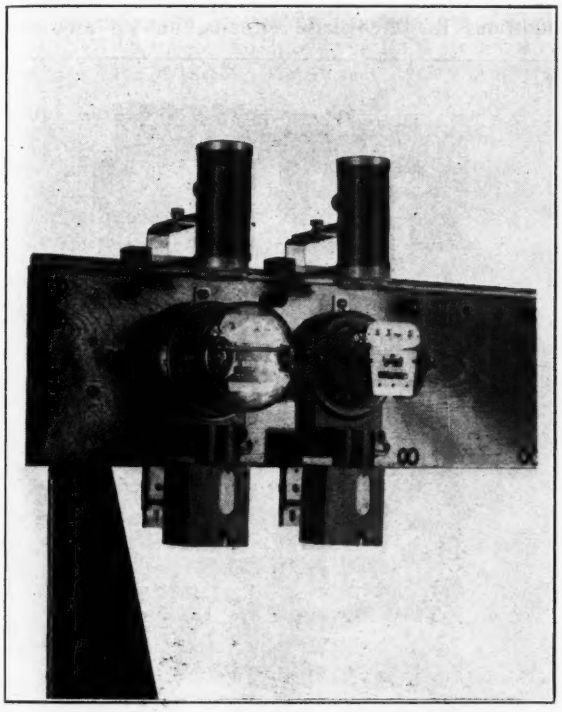


FIG. 2. WESTINGHOUSE APPARATUS FOR TESTING METERS BY MEANS OF A LIGHT RAY

error and mechanism errors in stop watches, a number of timing devices have been developed.

In Fig. 1 is a picture of a device of this kind known as the Mann Short-Interval Timer, designed by David L. Mann of the Jefferson Physical Laboratory at Harvard University to measure short intervals of time within the accuracy of the human factor. The dial is 3 in. in diameter and divided into ten seconds, each second graduated into tenths. The small hand counts on its dial the revolutions of the large hand and reads to 120 sec. or two minutes. The large hand makes one revolution in ten seconds by intervals of thirtieths of seconds and the balance is released and stopped for each observation. The device is of the start, stop and set back type, the action being similar to that of an ordinary stop watch, but due to the 3-in. dial and high period of vibration of the balance, the accuracy of the observations are well within the personal equation of even a highly-skilled observer. It is claimed that the starting and stopping error which is the largest source of trouble with most stop watches is eliminated in this device.

An interesting method of testing of watthour meters is shown in Fig. 2. With this, the meters are tested by means of a ray of light and extraordinary accuracy is obtained. The time can be measured to 1/1000 second and the error, if any, is printed on a paper tape.

An automatic timing device developed for use in calibrating master rotating standard watthour meters, by the Union Gas & Electric Co. is shown schematically in Fig. 3. The rotating standards are held to a constant load for 60 sec., the load being measured with a precision wattmeter. The timing device operated by a master clock closes the potential circuit of the standard, and at the end of the 60 sec. opens the circuit. The master clock is equipped with a photo-electric cell which operates a relay that sends an electrical impulse each second to the timing device. The electrical impulses from the master clock relay energizes the magnet A which operates the 60-tooth ratchet wheel and cam B which closes the mercury contact (C) causing the current to flow through polarized relay D every 60 sec. The polarized relay D closes or opens the standard potential circuit. A 3-pole, double-throw toggle switch E is used to start or stop the timing device and reverse the current to the polarized relay D. To operate, the ratchet is set at some point before the end of the 60-sec.

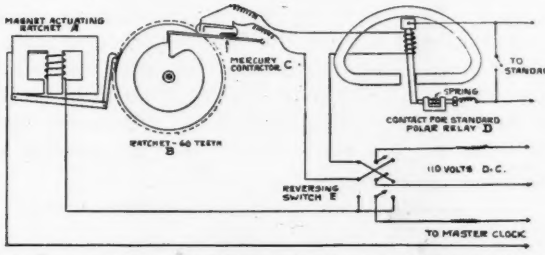


FIG. 3. WIRING OF TIMING DEVICE USED BY UNION GAS AND ELECTRIC CO., CINCINNATI

interval, and the toggle switch E is pushed up. After the mercury contact C has closed and opened the circuit, it is necessary for the operator to throw the toggle switch E to be shifted between two impulses, because the circuit of the magnet A is open when the toggle switch E is in the middle position.

Statement by the Bristol Company, Waterbury, Conn.

The ideal condition in a polyphase circuit is one of electrical balance, the several line voltages being mutually equal, and the respective currents alike in value. This condition, while frequently approximated, in some parts of a system at least, is seldom exactly maintained; and unbalance is a source of trouble and loss whose importance is often underestimated. While in the generation and transmission of electrical energy every care is usually taken to supply the consumer with a balanced voltage, the conditions of the load of that consumer or of some other use may be such the maintenance of that balance may be virtually impossible.

Assuming properly designed generating equipment and correctly transposed lines, unbalance generally originated in single-phase loads or groups of loads upon the system. These may be lighting loads, furnace or single-phase motors; and the unequal currents they draw from the system naturally result in unequal voltage drops

through the lines and transformers, with the result that the voltage available at the terminals of the load is no longer balanced; and this unbalance is likely to extend to other installations in the immediate vicinity.

The feature of unbalance, while objectionable from any point of view, is particularly troublesome in the case of induction motors. It is a characteristic of this motor that, when fed with unbalanced voltages, it auto-

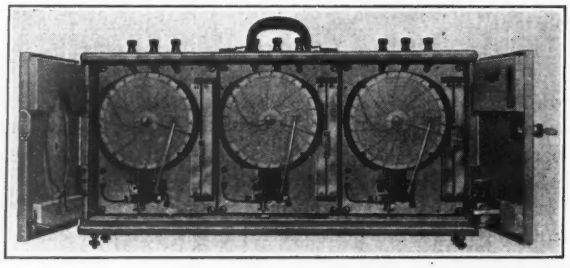


FIG. 4. THREE-PHASE RECORDING VOLTMETER DEVELOPED BY THE BRISTOL CO.

matically endeavors to correct the condition; and, to do this, it draws from the line of the voltages; so that a slightly unbalanced voltage supplied to an induction motor may produce a very badly unbalanced current condition. The circulating currents so produced, while flowing through the windings of the motor, do no useful work; and tests have shown that it is quite possible for a motor running light under this condition to be carrying its full load current, so that no mechanical load can be further imposed without causing the machine to overheat.

FIG. 5. GENERAL ELECTRIC CO. SINGLE-PHASE WATTHOUR METER

Not only does load unbalance seriously cut down the capacity of an installation, but the condition seriously interferes with the accuracy of all calculations embodying a consideration of power factor and reactive volt-amperes. Readings of the ordinary single current types of power factor meter lose their significance as unbalance develops; and one of the great problems of the present day rate meter has been to establish a fair and equitable basis for determining the costs of supplying power to unbalanced loads.

With these facts in view, the Bristol Company has produced a three-unit portable graphic instrument, available as a voltmeter or as an ammeter, and eminently suited for the investigation of conditions in circuits where a condition of unbalance may exist or be suspected. This recorder shown in Fig. 4 consists of three similar round-chart movements mounted in a convenient carrying case and wired to separate pairs of terminals. This makes a very convenient and flexible arrangement, and is suited, of course, not only to studies of unbalance conditions in three-phase circuits, but to any work

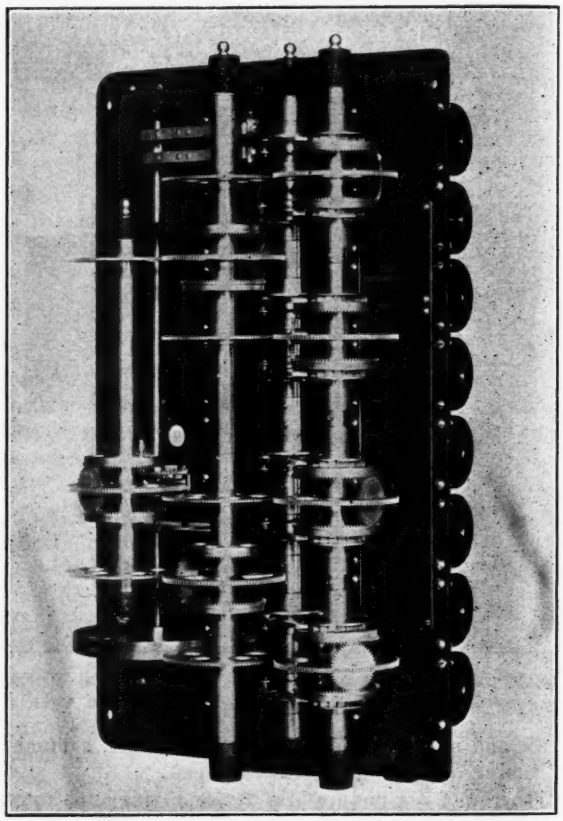


FIG. 6. GENERAL ELECTRIC TYPE DT-1 EIGHT-ELEMENT TOTALIZING RELAY

wherein is required a record of one or simultaneous charts of several voltages or currents.

STATEMENT BY THE GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

The outstanding development in the meter field is a new house-type watthour meter, Fig. 5, which combines marked improvements in overload performance with refinements in mechanical design. Loads up to 40 per cent of normal can be metered with good accuracy.

A new line of portable test meters has been added, in which temperature errors are practically eliminated, and which incorporate other improvements in performance and mechanical design. A new device known as the totalizing relay, Fig. 6, has been designed, which receives impulses from several watthour meters con-

nected in separate circuits and combines them so as to actuate a single demand meter.

Recent developments also include new portable and switchboard type strip-chart recording instruments, Fig. 7, in which the main features are especially wide charts, low losses, and internal self-contained resistor units.

Recording totalizing instruments have also been developed. These instruments totalize on one record power from various circuits of any voltage, phase, or frequency.

STATEMENT BY ROLLER-SMITH CO., NEW YORK, N. Y.

Among the new apparatus developed by this company recently two interesting products are the new Type COM Ohmmeter and the Type HTD circuit tester shown in Figs. 8 and 9. The former is a form of slide

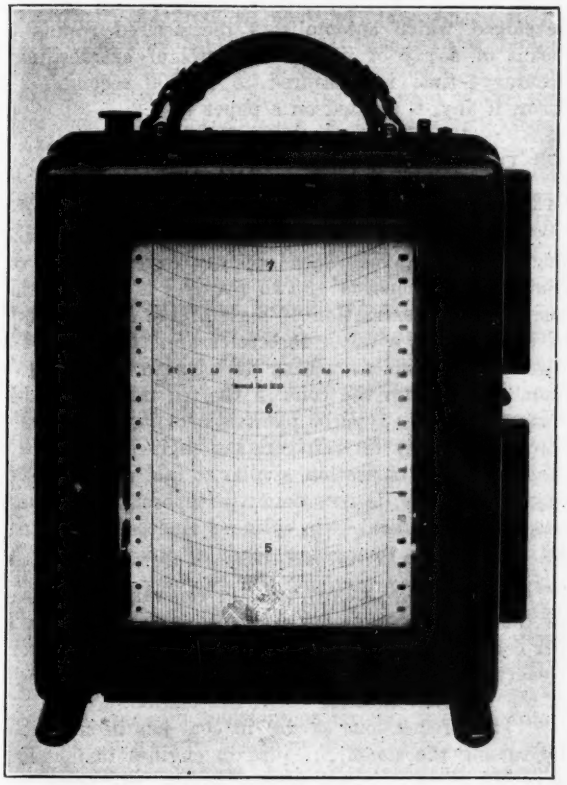


FIG. 7. GENERAL ELECTRIC CP-4 PORTABLE RECORDING WATTHOUR METER

wire bridge ohmmeter, designed with particular reference to speed and simplicity in operation and low initial cost. Its design is such as to make it an ideal instrument for the rapid measurement of coils and resistance units on a quantity production basis. The instrument is entirely self contained—there are no loose parts that may become lost. The instrument case is of black walnut, the overall dimensions being 5¾ by 9¾ by 4 1/5 in. There are four ranges, 0.5-50, 5-500, 50-5000 and 500-50,000 ohms.

To measure the ohmic resistance of a circuit attach the free ends of the two wires that form the terminals of the unknown resistance to the two "X" binding ports on the ohmmeter. Insert the plug attached to the flexible cord near the top of the instrument into any one of the four sockets marked, 1, 10, 100, 1000. Rotate the bakelite knob which is attached to the dial and at the same time depress the center button. If a balance on the galvanometer cannot be obtained with one complete revolution of the dial the plug should be shifted to the next socket and a revolution of the dial made again if necessary. When the galvanometer needle balances at zero the value of the resistance under measurement can be read on the dial. The numerals on the dial read directly when the ratio plug is in the socket marked 1. When the plug is in sockets of higher value multiply the scale reading by the value of the socket used. It is impossible to obtain a galvanometer balance with resistance lower than 0.5 ohm and in excess of 50,000 ohms, these figures being the minimum and maximum limits of the instrument's range. The combination of dial, operating knob and battery key in one member permits the operation of the instrument with

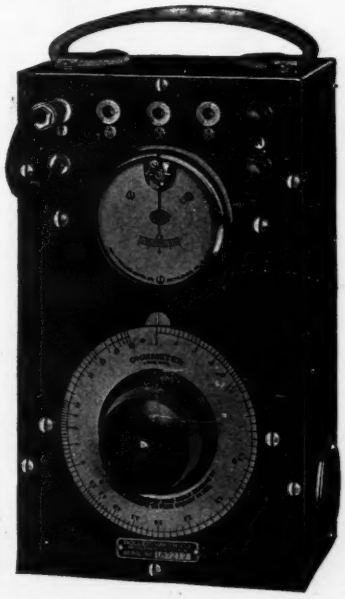


FIG. 8. ROLLER-SMITH COM OHMMETER

one hand, leaving the other hand free. The battery for this ohmmeter is self contained and consists of two standard cylindrical flash light cells.

The HTD circuit tester referred to has two uses. The instrument can be used to ascertain if there is an electrical circuit existing between conductors applied to the terminals of the instruments and, secondly, it enables the user to obtain an approximate idea of the resistance of the circuit under test. This instrument consists of a small high grade d'Arsonval type d.c. voltmeter (our TD mechanism) connected in series with a small dry cell. The circuit is such that when the two terminals of the instrument are connected the circuit is completed. The instrument pointer will indicate full scale when the terminals are short-circuited. The higher the resistance of the circuit under test the lower the scale reading will be and thus, in addition to showing whether or not a circuit is complete, an approximate idea can be obtained of its ohmic resistance.

The scale is divided into 50 uniform divisions of arbitrary value. Directly below the scale is located a

chart, by reference to which resistances up to 10,000 ohms may be calculated. For illustration, if the Circuit Tester is attached to a circuit, and the pointer shows 9 on the scale, by reference to the resistance chart it would be found that the resistance of the circuit is 1000 ohms.

The instrument is enclosed in a heavy sheet metal case with black finish and is equipped with nickel-plated binding posts.

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO., EAST PITTSBURGH, PA.

Several new developments have been made in the design and application of electric meters during the year. The development of the single phase Type OB watthour meter has been expanded until now two wire meters in 25, 50 and 75 amperes capacities and three-wire meters in 25 and 50-amp. capacities are available.

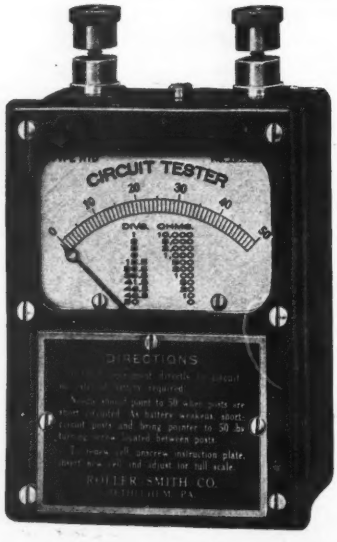


FIG. 9. ROLLER-SMITH HTD CIRCUIT TESTER

The design of the watthour meter for heavier current capacities is much the same as the design of the meter for 5 to 15-amp. capacities, except that larger current coils in the electromagnets, larger terminals and a deeper base are required. All parts of the heavy current Type OB watthour meter, except the electromagnet, terminals and base are now interchangeable with similar parts of the small capacity Type OB meters.

Another new meter is the Type OA reactive volt-ampere meter, supplied for use on single phase or polyphase service. The design is such that no special transformers, compensators or condensers are necessary to displace the voltage impressed on the shunt (potential) coils. In external appearance these meters are entirely similar to the standard Type OA single or polyphase meters.

In the design of the electromagnet the series and shunt fluxes are given the proper phase relation so that the meter registers the reactive component of the load (that is, in proportion to the size of the angle of phase displacement). For example, the fluxes are in phase with each other at unity power factor load and at other power factors are displaced from each other by an angle equal to the angle of phase displacement of the load.

The shunt circuit is wound so that it has considerably less inductance and more resistance than the shunt circuit of the ordinary watthour meter. This tends to bring the shunt flux back into phase with the applied voltage, but since it is not possible to make this circuit entirely non-inductive, the shunt flux will lag the applied voltage by some angle.

A new recording frequency meter (Fig. H on page 108) has been developed with which the frequency can be read to 1/100 cycle, (1/5000 sec.). Such extraordinary accuracy has only recently been needed in connection with interconnection of systems, and to check it, a new highly accurate device for creating frequencies of known values had to be built. The operation of this latter device is based on standard tuning forks, beams of light, a rotating disc, and photo electric cells.

In testing watthour meters, an apparatus has been developed which accomplishes the desired results by means of a ray of light. It allows of extraordinary accuracy—time is measured to 1/1000 second. The error, if any, is printed on a paper tape.

Refrigerating Plant Equipment

STATEMENT BY THE VILTER MFG. CO., MILWAUKEE, WIS.

THE "VILTER" Super-Flooded System for ice manufacturing plants has been recently developed by this company. It consists of two features of construction, one being the extraction of most of the heat of liquid of ammonia at a water forecooler and the second feature consists in shortening the length of travel of ammonia through the coils in the ice tank. The performance of this type of plant is proving to be a most interesting study for refrigerating engineers.

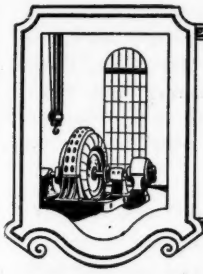
Force feed lubrication, similar to that on the present day automobiles, is now being incorporated on numerous sizes of vertical twin cylinder enclosed type single acting ammonia compressor, made by this company.

CONSUMPTION OF COAL used in generating electricity in the United States has been reduced more than 50 per cent in the last five years according to E. C. Stone, General Chairman of the Engineering National Section of the National Electric Light Association.

"This tremendous saving in coal has been effected by raising the steam pressure in engines to 600 lb.," says Mr. Stone. "Still greater saving will come with the advent of engines designed for 1200 lb. pressure, which are already under discussion.

"We are now extracting 18 to 20 per cent of the original energy from coal, whereas we formerly obtained from 2 to 10 per cent. Of course, this remarkable efficiency has caused many hydro-electric projects to be abandoned. We have also made great advances in keeping power lines 'live.' Most power systems today are so constructed so that if even a serious accident, such as a $250,000 generator burning out, should occur, the power can be resumed within a second or two."

ACCORDING TO A RECENT STATEMENT by the Department of the Interior to the Geological Survey, the total installed capacity in water power plants in the United States at the end of 1926 was 11,700,000 hp. for plants of over 100 hp. as against 13,100,000 hp. in Europe, presumably for plants of all sizes.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Electric Circuits and Distribution Systems

PART I. VOLTAGE DROP, CURRENT AND VOLTAGE IN CIRCUITS, POWER FACTOR, POWER LOSSES, MEASUREMENT OF POWER, TRANSFORMER LOSSES AND REGULATION

IN CONVEYING any commodity from one point to another, say from its point of manufacture to the point of use, it is usually desirable that the transference take place with the least possible loss both as regards quantity and quality. Since the function of an electrical conductor, transmission or distribution systems, is to convey electricity from its source of supply to the point of use, it must be so designed that this function will be accomplished in the most efficient manner. The conductors must be of such size that they will not absorb too great a percentage of the energy or become overheated when carrying normal loads. The problem of designing a distribution circuit, therefore, involves the determination of the proper size of conductor to be used to limit the loss of voltage to a specified amount when the distance and the current intensity are known. It involves further, determining whether the size of conductors needed for the specified voltage drop is sufficient to carry the current.

VOLTAGE DROP

The voltage drop between any two points on an electrical circuit is the difference in potential between those points, or the voltage necessary to pass the current through the series resistance or series impedance between those points. On transmission circuits the voltage drop is usually considered as the difference in effective voltage between conductors at the two points. This in the case of existing transmission circuits is easily determined by the use of voltmeters.

The allowable voltage drop for any circuit demands a study of the economics of the system, and in its determination two things must be considered; first, an annual fixed charge for interest and depreciation on the cost of the line wire; and second, the annual cost of the energy wasted in the conductor in the form of I^2R losses. The equality of these two items, by Kelvin's law, determines the size of the most economical conductor.

Without discussing its derivation, a convenient formula for the economic ohmic voltage drop per mile of copper conductor is as follows:

$$E = 9.35 \frac{\sqrt{a \times p}}{p_1}$$

and for aluminum

$$E = 6.57 \frac{\sqrt{a \times p}}{p_1}$$

in which a is the percentage to be taken to cover the annual interest and depreciation, p the price of 100 lb. weight of conductor and p_1 the cost per kw. year of the wasted energy.

PERMISSIBLE VOLTAGE DROP IN D.C. CIRCUITS

With ordinary d.c. circuits used in industrial plants, the voltage drop generally should not exceed 10 per cent for motor circuits, and it is better from an operating point of view not to exceed 5 per cent.

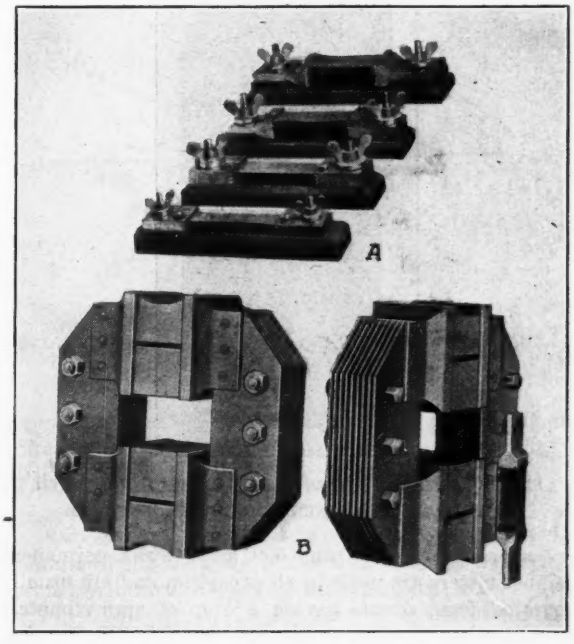


FIG. 1. VARIOUS TYPES OF SHUNTS USED IN MEASUREMENT OF CURRENT AND POWER. A, PORTABLE SHUNTS. B, A PAIR OF 20,000-AMP. SWITCHBOARD SHUNTS

For incandescent lamps operating at 110 v. nominal, the voltage at the most remote lamp should not be more than 3 v. below the nominal (110 v.) voltage; and some public service companies will not connect installations where the total voltage drop of the interior wiring system exceeds 1 v. Many other companies specify the total drop not to exceed 2 v. A lighting circuit from a central or substation should preferably have a drop of about 2 v. in the feeder circuit and 1 v. in the interior wiring for 110-v. service. These drops should be doubled for 220-v. services.

In a motor or mixed load circuit with several branches the total allowable drop may be arbitrarily apportioned; say 1 v. in individual branches, ⅔ of the remaining drop in the feeders and ⅓ in the mains supplying the feeders.

In determining the total voltage drop of an electrical circuit, the drop over switching equipment and bus bar connections must be allowed for. To keep this drop at a low value, the drop over switches and joints in bus bars should be tested from time to time by means of a millivoltmeter.

Current and Voltage in Circuits

The amount of current flowing in electric circuits is measured by ammeters, of either the indicating or recording type. Direct current ammeters of the moving iron type are built for connecting directly to the circuit

FIG. 2. A SINGLE PHASE VOLTAGE REGULATOR WITH AUTOMATIC AUXILIARIES MOUNTED ON PANEL

in capacities up to about 600 amp. while permanent magnet meters are made in all capacities and are usually operated from shunts having a drop of approximately 50 millivolts. Typical shunts are shown in Fig. 1. A.c. ammeters are made in certain types in capacities up to about 300 amp. for connecting directly in the circuit unless the voltage is high, but the better grades of instruments are operated from current transformers usually having a secondary current of 5 amp.

For measuring currents beyond the capacities of the ammeters at hand, two ammeters may be placed in multiple but in doing this, both instruments must be read simultaneously. If two shunts are used in multiple, special meters must be connected to each and readings taken on both.

In measuring high potential alternating currents, the usual method is to use current transformers in connection with low reading ammeters. Such transformers have a 5-amp. secondary. This secondary should not carry more current than that required by two instruments. The secondary circuit of a current transformer must never be opened while the current flows through the primary. If this precaution is not taken, there is danger of the transformer overheating and thereby breaking down the insulation. There is also danger to anyone handling the secondary owing to the high voltages induced.

Measurement of Current in a 3-Phase Circuit

To measure the currents in a 3-phase circuit, two equally rated current transformers and three ammeters are necessary. The primaries of the two transformers are placed in two of the lines connecting one lead of one secondary to the lead of corresponding polarity of the other secondary and joining the two remaining leads with a short circuiting wire. One ammeter is placed in each of the two separate transformer secondary circuits; the third ammeter goes in the short circuiting line and reads the current in the third phase.

The amount of current in the circuit, the voltage being constant, is obviously dependent upon the load and is therefore not under the control of the operator. The voltage of the circuit is, however, under control either manually or automatically and it is highly essential that the voltage be maintained at a uniform value. In many stations this is accomplished by controlling the voltage of the electric generators by means of automatic voltage regulators.

In large central stations, the voltage of the generator voltage is not usually under automatic control but each feeder is equipped with an induction voltage regulator which varies the voltage of that feeder without affecting the voltage conditions of any other part of the system. In effect such an induction regulator is a variable ratio transformer or rather auto-transformer, having two separate and distinct windings; i. e., a primary and a secondary. The primary winding is connected across the feeder to be controlled, while the secondary winding is connected in series with the feeder. The product of the volts and amperes on the generator side less a small loss in the regulator itself is always equal to the product of the voltage and the amperage on the feeder side.

The mechanical construction of regulators varies with different manufacturers but the basic principles of operation are the same. The majority of them are automatically operated, and when so arranged are provided with auxiliary devices whereby the voltage at any given center of distribution may be maintained constant at any predetermined value, regardless of the load or the power factor of the load.

Power Factor

The power factor in an alternating current circuit is the ratio of the actual power to the apparent power. It is the number by which the apparent power must be multiplied to get the real power. Mathematically, it may be expressed as the cosine of the angle of lag or lead between the voltage and the current flowing in the circuit.

To make this clear it must be understood that inductance in an alternating current circuit, causes the current to lag behind the voltage impressed on the circuit. The effect of capacity in the circuit, on the other hand, causes the current to lead the voltage. The effects of inductance and capacity, therefore, are op-

posite and under certain conditions may exactly neutralize each other. In such a case, the current will be in phase with the impressed voltage, as it always is in a direct current circuit, and the power factor would be unity. If only inductance were present, the current would lag behind the voltage by an angle proportional to the inductance and the cosine of the angle of lag would represent the power factor.

Power factor may be measured directly by means of a power factor meter, which indicates the power factor, lagging or leading as the case may be or it may be determined from simultaneous readings of a voltmeter, ammeter and a wattmeter connected to the circuit. In using the latter method the following formula is used to arrive at the power factor.

$$P.F. = P \div (I \times E)$$

where P is the power in watts as registered by the wattmeter, I, the current indicated by the ammeter and E, the voltage.

Of course, it is, no doubt, superfluous here to refer to the advantages of maintaining the power factors as near unity value as possible. The effect of low power factor in a constant potential circuit is to increase the current necessary for the transmission of a given amount of power over that current which would transmit the same power in a circuit of unity power factor; that is, in circuits of low power factor the wattless current is considerable.

Open Circuit Voltage of Current Transformers

By Carl W. Evans

ALL POWER engineers having electrical equipment under their care are more or less familiar with the high voltage generated in the secondary of current transformers upon open-circuit while the primary is carrying load. The effect of such high voltages upon the transformer is most injurious, producing such results as: the damaging of insulation due to increase in core losses and the accompanying heat; the possible magnetizing effect producing changes in operating characteristics; and even danger to life itself. The majority of engineers in the field, however, are not familiar with just what the magnitude of this voltage may be, nor the factors that cause it to vary.

Studying individually, by means of vectors, the factors involved, a conception of the phenomena is rapidly obtained. Referring to the diagram:

E_2 = secondary induced voltage;
I_2 = secondary current;
ϕ_2 = flux due to secondary ampere-turns;
I_1 = primary current;
$-I_2$ = secondary current reversed;
I_{c1} = core loss component of primary current;
I_m = magnetizing component of primary current;
I_x = total exciting component of primary current;
ϕ_1 = flux due to primary ampere-turns;
ϕ_3 = effective flux; that is, the resultant of ϕ_1 and ϕ_2.

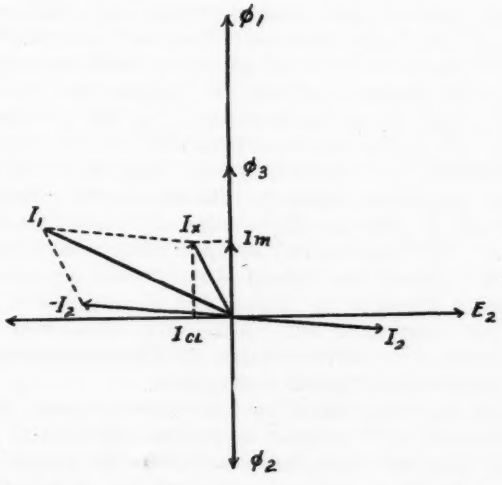
The primary current, I_1, in the primary winding, establishes a flux ϕ_1. This flux has a tendency to generate the secondary voltage, E_2, but since this voltage is closed through a low resistance circuit, the current I_2 is established, which in turn establishes the flux ϕ_2, practically 180 deg. out of phase with the flux ϕ_1. The resultant of ϕ_1 and ϕ_2 is ϕ_3, which is the flux effective in establishing the value of the secondary induced voltage, E_2.

From this it will be seen that if the secondary winding is open-circuited, the current I_2 will fall to zero, and as a result, the flux ϕ_2 will also fall to zero. Since ϕ_2 is equal to zero, the effective flux ϕ_3 will be equal to the flux ϕ_1, due to the primary ampere-turns, making the secondary induced voltage, E_2, a maximum, which may be a dangerous value.

The exact value of the secondary voltage upon open-circuited secondary, may be determined by the formula:

$$E_2 = I_1 Z_1 R$$

where Z_1 is the impedance of the primary winding with



VECTOR RELATIONS OF CURRENT, VOLTAGE AND FLUX IN CURRENT TRANSFORMERS

secondary winding open-circuited; $I_1 Z_1$ thus being the voltage drop across the primary winding; and R, the ratio of secondary to primary turns.

Amount of electrical power equipment in the manufacturing industry in the United States has nearly trebled within a decade, constituting in 1925 a total of 26,123,573 hp., or 73 per cent of the total primary power equipment in manufacturing, according to an analysis made by the National Industrial Conference Board, 247 Park Ave., New York. This gives the United States first place among leading industrial countries, Germany being a close second, with industrial power equipment 66 per cent electrified, while Great Britain lags considerably behind, with only 48 per cent electrified.

The Seventh Annual Report of the Federal Power Commission has just been issued. This discusses the newest hydro-electric projects proposed, together with many details of the commission's activities in connection with them. Copies may be obtained from the Supt. of Public Documents, U. S. Government Printing Office, Washington, D. C., at 25 cents per copy.

Power Problems Considered at Washington

BOULDER CANYON, ST. LAWRENCE, GREAT FALLS, MUSCLE SHOALS AND UMATILLA RAPIDS WILL CLAIM ATTENTION OF CONGRESS. BY WINGROVE BATHON*

NOW THAT Congress has convened at Washington, it seems proper to make a survey, from a national point of view, of proposed power legislation and reactions to these proposals in Congress, in the Federal Government executive departments, in State governments and in private industry.

There never were so many groups of proposed legislation on power matters before Congress as there are this year; there never has been so much involved as now in the way of desired appropriations running into the hundreds of millions of dollars for power purposes; there never have been so many excuses and subterfuges for obtaining Federal money and putting the Government into the power business under one guise or another; but, more important than all, perhaps, there never have been involved in such a situation so many and such important principles. The first and foremost of the latter, perhaps, is the growing cry for Government ownership and operation, which would put the Government actively in the power business in competition with private industry. The second most important of these is, perhaps, the question of "State's Rights," with various actions in the states which would lead to breaking down the Federal Water Power Act in some cases, and which in others assert more rights of control or taxation or both by the states themselves than they have ever asserted against the Federal Government in hydro-electric power development.

Among the outstanding features of proposed power legislation at Washington is the Boulder Canyon Dam bill. That is a flood control and irrigation project, and it is sought to make a power project of it. Other projects are included in the St. Lawrence waterway proposals. Those are primarily navigation projects with water supply features, but it is sought to make power projects of them. There is the proposal to build a $40,000,000 or $50,000,000 hydro-electric project at Great Falls (in the District of Columbia and Virginia and Maryland) with Government money, to supply power and light to the city of Washington and nearby communities. On that there is no masquerade. It is all power and light. There is the perennial subject of Muscle Shoals, which was built originally as a war-time nitrate project and which some have insisted shall become a peace-time fertilizer project. But that is a power project pure and simple and will finally be proven to be so at this session of Congress. There are the Columbia Basin and Umatilla proposals out on the Pacific Coast, which are canalization and navigation projects, but it is also sought here to make some of them power projects. There are a mass of flood control measures for the Mississippi and many of its great tributaries. But in these, also, one observes beginning to rise various proposals for power.

Six or seven committees of Congress will battle with these subjects beginning immediately. So far as Muscle Shoals is concerned, Senator McNary, of Oregon, Chairman of the Senate Committee on Agriculture and Forestry, which has charge of that legislation in the upper House, states to a Washington representative of Power Plant Engineering, that he has promised President Coolidge that he will endeavor to bring proposed legislation out of his committee immediately. It is expected by Senator McNary and a majority of his committee members that the proposal of Senator Norris of Nebraska, which failed of consideration on the floor of the Senate in the closing days of the last session, although favorably reported out of the committee then, will again be favorably reported. The passage of the Norris legislation on Muscle Shoals in the Senate, however, as well as reporting it out of the committee, may be delayed by the possibility that there will be an administration bill at last after so many years of legislative discussion of this subject. It is known that Secretary Jardine of the Department of Agriculture looks with favor upon a plan to "dispose" of Muscle Shoals power under a measure which would yield the Federal Government about $2,000,000 or a little more a year, which money could be used by his department in large-scale experiments for obtaining nitrogen for fertilizers and in educating the farmer to the use of concentrated fertilizers. That money would be obtained by the sale of the power at the switchboard to the power companies. No administration bill has yet appeared; but proposed Muscle Shoals legislation is such a hoary-headed grandfather around Washington that all those who are sick of the subject are hoping that it will have the assistance of a young and vigorous administration support now. On this subject the President says in his annual message to Congress the following:

"Last year has seen considerable change in the problem of Muscle Shoals. Development of other methods show that nitrates can probably be produced at less cost than by the use of hydro-electric power. Extensive investigations made by the Department of Agriculture indicate that the nitrate plant on this project is of little value for national defense and can probably be disposed of within two years. The oxidation part of the plant, however, should be retained indefinitely. This leaves this project mostly concerned with power. It should nevertheless continue to be dedicated to agriculture. It is probable that this desire can best be served by disposing of the plant and applying the revenue received from it to research for methods of more economic production of concentrated fertilizers and to demonstration and other methods of stimulating its use on the farm."

This message from the President has created a profound impression on the House side of the Capitol where Muscle Shoals is dealt with by the House Military Affairs Committee. This committee has been working for a couple of years on a proposal made by the American Cyanamid Co. and the Union Carbide Co. which has for its basis a promise to make fertilizer by the out-worn cyanamid process for which the Muscle Shoals nitrates plants were built. It has been fostered in the House by no less a person than Martin B.

*Washington Correspondent of Power Plant Engineering.

Madden, of Illinois, the powerful chairman of the Committee on Appropriations. That bill has been reintroduced in the House but it may just as well be said here and now that it stands no earthly chance of passage by either the House or the Senate. Indeed, the President's message, pointing out that the cyanamid nitrate plant at Muscle Shoals is of little value for national defense and can probably be disposed of, was a bomb-shell to the proponents of that measure.

Representative Morin, of Pennsylvania, Chairman of the House Committee, is not prepared to predict what his committee will do. Nor is there any group of House Military Affairs Committeemen sufficiently in accord to indicate what that committee will do.

Speaking generally, however, it may be said that Senator Norris' proposal involves certain features of Government ownership and operation not favored at this time by a majority of the House Committee nor by the responsible Republican leaders of the House of Representatives. Even among the proponents of the offer of the associated power companies of the South to lease and operate Muscle Shoals, there is not great opposition to Senator Norris' bill, if he would take out of it one or two things. It is understood that the power men feel that Senator Norris' bill should not contain a provision permitting and authorizing the Secretary of War to build transmission lines in the Southeastern territory contiguous to Muscle Shoals for the taking away of the surplus power after nitrogen needs have been met, because the granting of such authority would forever hold over the power companies the menace of Government competition. It is understood that the power company executives also feel that Senator Norris' bill should not contain a clause, as it does, granting the preference for the purchase of surplus power from Muscle Shoals to states, municipalities, etc., because that provision would certainly cause a great many small communities to go into the power business for themselves in competition with the power companies. If those two provisions could be liberalized there is not much opposition to Senator Norris' bill from a power point of view. He is known to be honest and sincere and consistent and he has almost always been right in his whole conduct of the Muscle Shoals fight. It was he, more than anyone else, who led the great fight to prove that Muscle Shoals is a power project and not a nitrogen project. In these circumstances, there is a good chance that there will be another failure at this session of Muscle Shoals legislation, unless there should be some crystallization of leadership in the Republican administration at Washington, particularly on the part of the Secretary of Agriculture and Secretary of War, the first, in connection with the subject of nitrogen for fertilizers for the farmers, and the second on the subject of nitrogen for national defense, as well as distribution of the surplus power from Muscle Shoals.

Colorado River Project Has Cabinet Support

The proposed Boulder Dam legislation was another bill which fell by the wayside in the closing days of the last Congress. In the Senate this is in charge of Senator Phipps, of Colorado, Chairman of the Senate Committee on Irrigation and Reclamation, Senator Phipps, a power man himself in private life, being opposed to the legislation on various points, with the leadership in behalf of it resting upon the shoulders of Senator Johnson, of California. Innumerable hearings on this legislation have been held, and during the past summer various conferences have been held in the seven states affected by the Boulder Dam legislation, with the lines remaining at this time still sharply drawn for and against and no prospect of an agreement. New hearings are just about to begin before the House Committee. At the office of the Chairman of the Senate Committee, it is doubted whether there will be any more hearings on the subject and the latest information available there is that Senator Johnson will reintroduce his bill with some amendments of a minor character, and no immediate prospect of the passage of the bill by the Senate.

Secretary Work, of the Interior Department, in his annual report has again urged passage of the Colorado River bill. He does not specify that the dam should be built at Boulder. On the location of a Colorado River dam there is wide divergence of engineering opinion, nevertheless the Secretary of the Interior is in favor of the Government going into the power business in connection with the Colorado River, his position being that if the Government could not obtain a suitable lease from private industry willing to generate and distribute hydro-electric power, the Federal Government should itself generate and sell the power at the switchboard. More than likely the fate of the Colorado River bill, otherwise known as the Boulder Dam bill, will depend upon what agreement can be made among themselves by the states which would be affected by the legislation. Each of the states has asserted itself on rights or what it claims to be its rights and this question will be threshed out in Washington this winter, with, perhaps, the assistance of the Attorney General.

As it happens, the subject of "State's Rights" in Federal water power dams is before the Attorney General for an opinion now, in the Muscle Shoals matter. The state of Alabama made certain claims as to ownership of the bed of the stream (the Tennessee River) as well as rights connected with the water itself and at the suggestion of President Coolidge, Senator McNary, Chairman of the Senate Committee on Agriculture, asked the Attorney General for an opinion. Presumably this will be forthcoming shortly.

Secretary Work and Secretary Hoover are both ardent supporters of the Colorado River bill. Some form of such legislation is also favored by President Coolidge. But Chairman Madden, of the House Appropriations Committee, is opposed to such legislation and has announced that Congress will not be able to spare any funds for Boulder Dam, and that (so far as he can) he will not permit any other appropriation of Federal money to build dams at Government expense for the benefit of private power companies. Secretary Hoover and Secretary Work are willing to have the Government get through at the switchboard at Boulder Dam and have the power companies purchase the energy there. Senator McNary is very strongly for that and for nothing else. He cannot go along with his colleague, Senator Norris, on the building of Government electrical power transmission lines. It seems curious to note, and it certainly ought to be recorded here, that most of the cry

for Government ownership and operation of hydroelectric power projects in connection with Boulder Dam comes from within the Cabinet of President Coolidge. It is a matter of unrecorded public history that when this proposition came from the Secretary of the Interior, Senator Hiram Johnson, of California, when told of it, felt as if someone had thrown manna from the skies in his direction. Of course, incidentally, it ought to be said that Secretary Work and Secretary Hoover had no intention of letting Senator Hiram Johnson take all the credit there might be in meeting the wishes, in some form, of those who wanted the Colorado River floods controlled. Thus on the one hand, we see Secretary Hoover and Secretary Work in favor of Government ownership and operation at Boulder Dam but against it in other power projects; we see Representative Madden, of Illinois, in favor of his own Muscle Shoals bill, which would involve an appropriation for the benefit of the American Cyanamid Co. and the Union Carbide Co. in the construction of a storage reservoir dam known as Cove Creek, but against an appropriation for Boulder Dam; and we even see President Coolidge himself advising the "disposition" of Muscle Shoals, but advocating some form of Colorado River flood control and irrigation and power legislation.

Power Market Apparently Holds Up Great Falls Development

The Great Falls bill, which has been a pet measure for a long time of Senator Norris, of Nebraska, the leader of the Government ownership and operation forces in Washington, will be reintroduced by him with no prospect of immediate action by both Houses. This bill has met with favorable consideration by the Senate upon several occasions, and Senator Norris can probably pass it in the Senate again, but its fate in the House is not so rosy. The curious fact about the proposed Great Falls power development is that almost everyone admits that unless excess power and light not required for the use of the Federal Government buildings and other activities in Washington, as well as use by private industry and householders could be disposed of in Baltimore and other accessible cities, the project should not be built. On this point W. F. Ham, President of the Potomac Electric Power Co., which owns the site or sites of the dam or dams proposed to be built for the Great Falls project, has the following to say:

"As to the market for power outside of Washington, I would suggest that this be given most careful consideration. My understanding is that hydroelectric development is now being undertaken on a large scale by the American Waterworks & Electric Co., or through its subsidiaries, in Maryland, West Virginia and Virginia, which makes it quite possible that hydroelectric power from one or more of these developments may be delivered into Washington even before the Great Falls project could be completed, and at a cost which would be comparable to the power obtained from said project.

"Also I know that Baltimore is already partially supplied with hydroelectric power from the Susquehanna River and that due to its large industrial load and more favorable freight rates Baltimore can produce power by steam at a cost lower than is possible here in Washington. On account of more favorable load and more favorable freight rate, they are in position to produce power by steam cheaper than it can be produced by steam in Washington. Therefore, there would be less likelihood of our competing with steam in Baltimore than there is of their competing with steam in Washington."

Irrigation and Reclamation Figure in West Coast Project

On the Columbia and Umatilla proposals, hearing will begin before the Senate Committee on Irrigation and Reclamation shortly after the session begins, notwithstanding the fact that there was an adverse report on this legislation from the Secretary of the Interior and the Director of the Budget in the closing days of the last session. Senator McNary explains to the writer that notwithstanding the opposition of the Secretary of the Interior and the Director of the Budget to this legislation, there is pressure in his section of the country for the passage of this legislation. The report in opposition to this legislation did not gain publicity when it was made. It is, in part, as follows:

"This bill provides that there shall be constructed and operated and maintained at the Umatilla Rapids in the Columbia River, about two miles above the town of Umatilla, Oregon, a certain dam to raise the water in the river above the same to an elevation of 310.5 ft. above sea level, together with a power plant for the fullest economical development of the electrical energy available from the normal flow of the Columbia River and for suitable locks for the improvement of navigation on the river. This work to be done under the supervision of the Secretary of the Interior, with funds made available by the Secretary of the Treasury within appropriations made therefor not exceeding $45,000,000 by advance from a special fund created for this purpose, which fund with 4 per cent interest on advances made shall be secured by bond issues.

"The bill also provides for advance assurance of sufficient revenue to repay all cost within fifty years from the date of completion of the project and authorizes the Secretary of the Interior to contract for delivery of water for irrigation and domestic uses and for power to municipal corporations, political subdivisions, etc., for a period not exceeding 50 yr. with provision for extension of this term. Section 7 of the bill also provides for withdrawal of vacant public lands susceptible of irrigation in that vicinity and subsequent opening for entry under the provisions of the reclamation act with assessment of the cost of construction in instalments to be specified by the Secretary of the Interior, in accordance with the provisions of the reclamation law.

"No appropriation is authorized for the construction of the required irrigation works.

"Under the authorization contained in the Act of Congress, approved February 21, 1923, this project was investigated, the dam site was drilled, preliminary canal lines were run for irrigation of adjacent lands by pumping and designs and estimates prepared. The results of this investigation show that a dam to produce a constant output of 420,000 hp., except on rare occasions, with navigation locks and power development facilities, would cost $45,000,000; that some 50,000 acres of land

could be irrigated under a lift of 489 ft. on the Washington side at an estimated cost of $116 per acre for construction and $8.41 per acre annually for operation and maintenance; that on the Oregon side one tract of 6000 acres is under a 486 ft. pumping lift with an estimated construction cost of $218 per acre, and an annual operation and maintenance charge of $14.39, and another tract of 38,000 acres under a pumping lift of 461 ft., at an estimated construction charge of $249, and an annual operation charge of $11.19 per acre. The irrigation of these lands does not therefore appear feasible at the present time.

"The bill has been submitted to the director of the Bureau of the Budget, who states that the proposed legislation is in conflict with the financial program of the President."

The St. Lawrence waterway projects, and the flood control bills, involving power proposals are yet to come. From all signs there will be literally a flood of the latter, and they will be separately treated in this correspondence.

Latest Practice in Small English Power Plant

CARLISLE STATION USES EVAPORATORS, STAGE HEATING, DEAERATORS AND COMPLETE INSTRUMENT EQUIPMENT

INCREASING demands for service have made necessary a new station which, while using some old equipment is laid out on modern lines for 17,000 kw. ultimate capacity. In general there are parallel boiler and turbine rooms with a bay between for piping and auxiliaries, a switch-house annex and a separate pump house on the river bank for circulating and service pumps.

Usual conditions obtain as to pressure, 255 lb., temperature, 600 deg., and vacuum, 29.1 in. Boilers are each for 30,000 lb. of steam an hour with overhead bunkers, coal weighers, underfeed stokers, economizers, induced draft and sluicing ash removal. Ring steam header supply is used in contrast to the unit system now adopted in this country.

Boilers are equipped with steam flow meters; thermometers for superheat, feed water and flue gases; draft gages and CO_2 recorders.

Feed water make up is evaporated by exhaust steam from feed pumps augmented, if necessary, by live steam. All condensate and drip discharge is sent to surge tanks so that all feed water passes the deaerator before going to the boiler. Each deaerator has an ejector heater for condensing steam used by the ejector to maintain vacuum in the deaerator; a vapor condenser; a direct heater to raise water to deaerating temperature; and the deaerator chamber where air and gases are given up.

On its way to the deaerator, condensate traverses the ejector air-pump condenser, ejector after heater and bled steam heater into a common ring in air which is connected to the surge tanks and the deaerators. Bled steam is used at 8 lb. pressure, final temperature at the economizer inlet being 150 deg. Electrical thermometers are provided for all heaters also indicators for oxygen after passing the deaerator, all to register on a distant control board.

Boilers are set along one side of the room, facing the light, and turbine center lines parallel the length of the building, while condensers set crosswise. Generators are self-ventilating with closed air circulation, cooled by the circulating water. Distant recording thermometers register temperatures at various points of the windings.

Motor-driven condensate and circulating pumps, with float control to prevent depriming, and steam-ejector air pumps are used. Cooling water pumps are located 2 ft. below river bed level, driven by vertical motors, and draw water through traveling screens which are cleaned by water jets. Water piping is largely outside the building, inside pipes being carried below the floor.

Switch gear is enclosed in compartments of artificial stone, oil-break switches being operated from a storage battery.

Indicating and recording instruments are arranged in the control room where also are generator panels in a main bank and pedestal control in front for exciter control.

Local transmission is at 3000 v., stepped up to 11,000 v. for outlying areas.

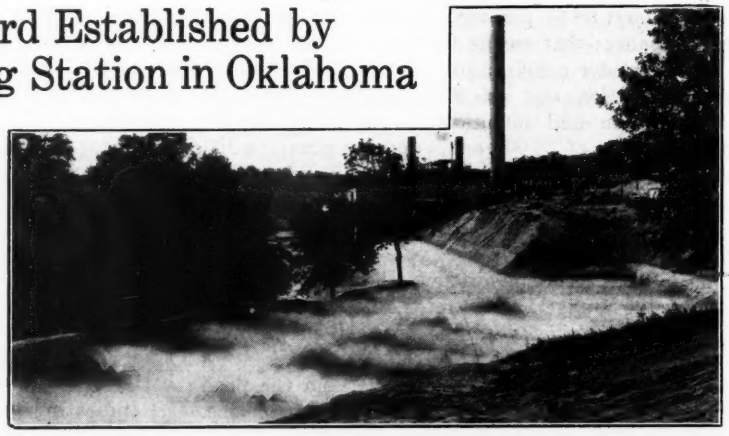
Proportions of equipment are as follows:

Apparatus	No.	Capacity (each)	Operating Conditions
Boilers and superheaters	4	30,000 lb. hr. 9295 sq. ft.	255 lb. 600 deg.
Coal bunker	1	160 t.	
Evaporators	2	6500 lb. hr.	
Deaerators	2	90,000 lb. hr.	Temp. rise 20 deg. F.
Bled steam heater	1		8 lb.—final temp. 150 deg.
Turbine	1	6000 kw. new	250 lb., 29.1 in., 3000 r.p.m.
Alternators	1	3000 kw. old	3300 v., 50 cycles
Alternators	1	2500 kw. old	3300 v., 50 cycles
Condenser	1	65,000 lb. hr. 9500 sq. ft.	29.1 in. 9500 g.p.m. cooling water
Pumps—			
Circulating	2	588,000 g.p.hr.	120 hp. mtrs., remote control
Condensate	2	65,000 lb. hr.	13-hp. motors, 1440 r.p.m.
Air ejectors (2-stage)	2	35.5 lb. hr.	29.1 in. intermediate and after condensers
Traveling screens	2	1,200,000 g.p.hr. at minimum	32 ft. hr., 11 ft. min. immersion
Screen jet pumps	2	27,000 g.p.hr.	66 ft. head

CONSUMPTION OF FUEL OIL in this country is largely concentrated in the states located directly on the seacoasts, says the United States Bureau of Mines, Department of Commerce, following a survey of gas oil and fuel oil distribution during 1926, conducted in co-operation with the American Petroleum Institute. Four-fifths of the national domestic deliveries of these oils were made in the states bordering the Pacific and Atlantic oceans and the Gulf of Mexico. Three states, California, Texas and Louisiana, accounted for 43 per cent of the national domestic distribution. The survey, made by E. B. Swanson, economic analyst, covered a distribution of 340,481,000 bbl., amounting to approximately 97 per cent of the oil marketed. Copies of the complete report may be obtained from the United States Bureau of Mines, Department of Commerce, Washington, D. C., or from The American Petroleum Institute, 250 Park Ave., New York.

POWER DEVELOPMENT in the southern Appalachian region has developed rapidly since 1919, 570,000 hp. in motors being installed. At present industrial workers have available 4.17 hp. each as against an average of 4 hp. for the entire United States.

Construction Record Established by O. G. & E. at Byng Station in Oklahoma



OWING to the increased demand for power in the Seminole Oil Field, the Oklahoma Gas & Electric Co. found it advisable to increase the capacity of their Byng Station.

Two 6000-kw. Allis-Chalmers turbo-generators with necessary auxiliaries and four 600-hp. Babcock & Wilcox boilers were moved from the Riverside Station in Minneapolis, and placed in operation at the Byng Station in record time, according to an article appearing recently in Byllesby Management.

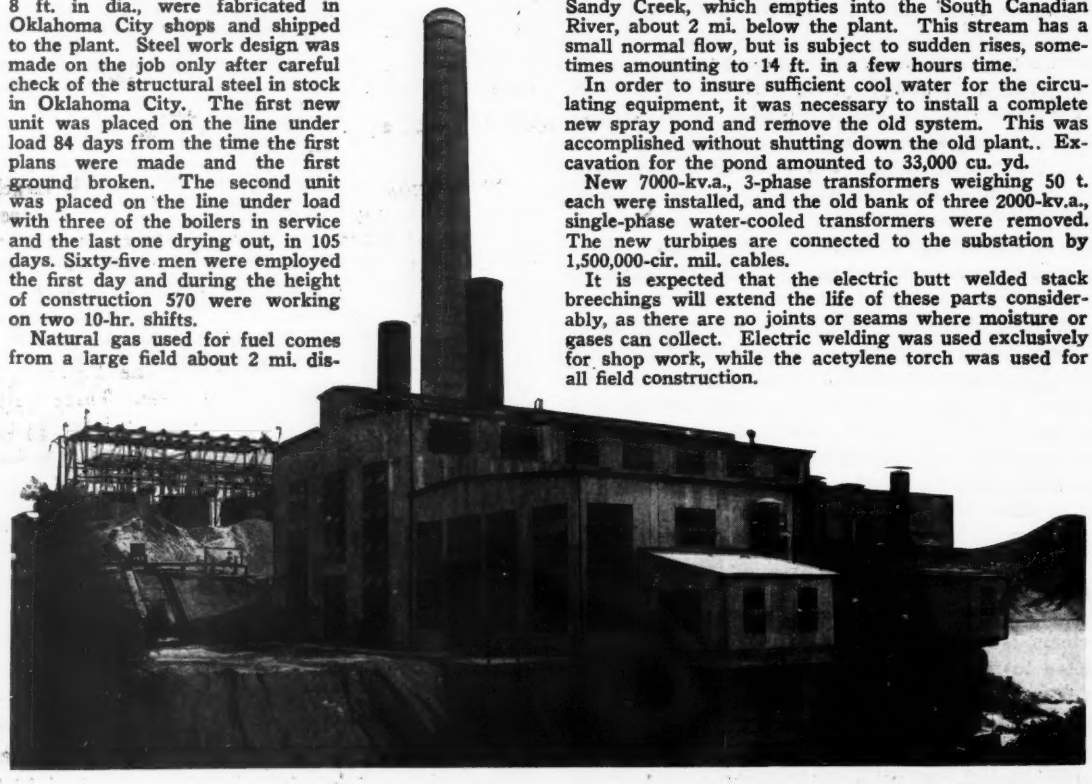
Two steel stacks, 48 ft. long and 8 ft. in dia., were fabricated in Oklahoma City shops and shipped to the plant. Steel work design was made on the job only after careful check of the structural steel in stock in Oklahoma City. The first new unit was placed on the line under load 84 days from the time the first plans were made and the first ground broken. The second unit was placed on the line under load with three of the boilers in service and the last one drying out, in 105 days. Sixty-five men were employed the first day and during the height of construction 570 were working on two 10-hr. shifts.

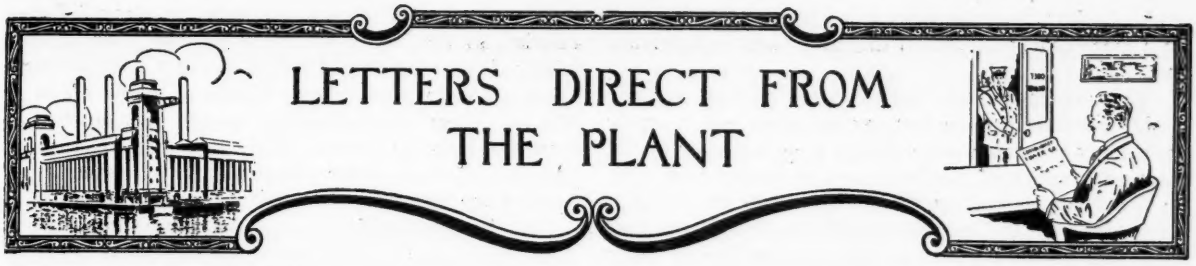
Natural gas used for fuel comes from a large field about 2 mi. distant. The plant is located on the east bank of Big Sandy Creek, which empties into the South Canadian River, about 2 mi. below the plant. This stream has a small normal flow, but is subject to sudden rises, sometimes amounting to 14 ft. in a few hours time.

In order to insure sufficient cool water for the circulating equipment, it was necessary to install a complete new spray pond and remove the old system. This was accomplished without shutting down the old plant. Excavation for the pond amounted to 33,000 cu. yd.

New 7000-kv.a., 3-phase transformers weighing 50 t. each were installed, and the old bank of three 2000-kv.a., single-phase water-cooled transformers were removed. The new turbines are connected to the substation by 1,500,000-cir. mil. cables.

It is expected that the electric butt welded stack breechings will extend the life of these parts considerably, as there are no joints or seams where moisture or gases can collect. Electric welding was used exclusively for shop work, while the acetylene torch was used for all field construction.





Attachment Improves Damper Regulation

By utilizing parts of discarded apparatus, an attachment for improving the action of a damper regulator used for controlling a forced draft fan, was easily made as follows: A well known damper regulator, a recording steam pressure gage, an indicating steam gage and a recording forced draft pressure gage calibrated to read from 0 in. to 6 in. water pressure, were mounted as shown in Fig. 1 on a ¼ in. thick boiler plate and placed in a convenient location. The last named instrument was reconstructed from the recording mechanism of an obsolete CO_2 machine which had a light metal bellows to drive the pen across a chart printed specially for this purpose.

The regulator has a vertical stroke of 10 in. and to its piston a 4-in. link was attached through a ½ by 1¼-in. beam whose fulcrum is 36 in. from the link and so placed that the beam is horizontal when the piston is at bottom end of the stroke.

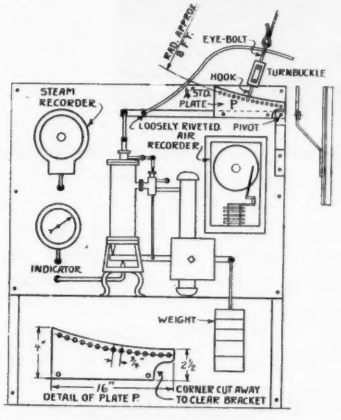


FIG. 1. DISCARDED APPARATUS FURNISHES PARTS FOR IMPROVING REGULATION OF DAMPER

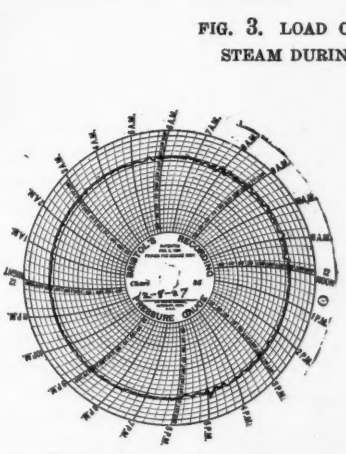


FIG. 2. CHART SHOWING REGULARITY OF STEAM PRESSURE DURING 24-HR. RUN

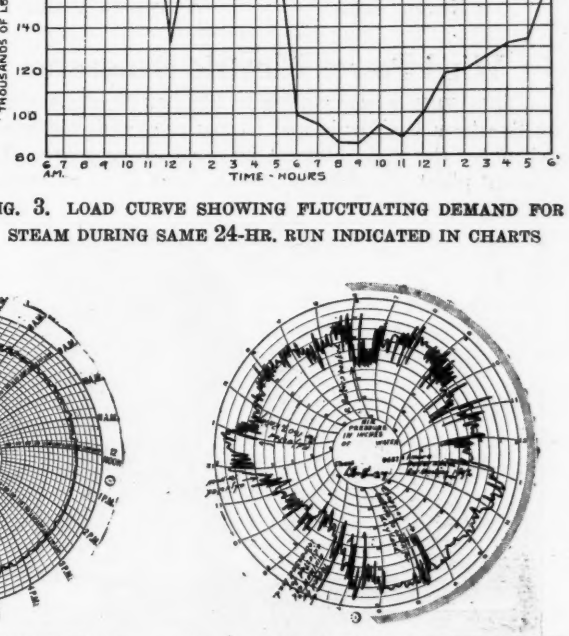


FIG. 3. LOAD CURVE SHOWING FLUCTUATING DEMAND FOR STEAM DURING SAME 24-HR. RUN INDICATED IN CHARTS

FIG. 4. CHART SHOWING FLUCTUATIONS IN AIR PRESSURE DURING SAME 24-HR. RUN INDICATED IN FIG. 2

On the pivoted end of the beam a ¼-in. thick plate of the size and shape shown in sketch is placed. From this plate, by means of a turnbuckle and cable the motion is transferred over a grooved pulley to a chronometer type valve in the steam supply to the blower. The bottom eye on the turnbuckle is shaped into a hook, and through the top eye a ⅜-in. rod is locally passed. This rod is curved as shown and attached to the beam at a point about 4 in. from its end by means of a swivel joint.

This rod prevents the top "eye" from turning when the turnbuckle is adjusted, yet easily works through the eye as the beam travels or as the hook may be transferred from hole to hole in the plate. The holes in the plate are centered and drilled after everything else is in place. Using the groove in the pulley as a center, and holding the beam all the way down, an arc is described on the plate and on this arc suitable sized holes are drilled, about ¾ in. apart to fit the hook.

Adjustment is made as follows: Hold the beam all the way down and adjust the turnbuckle for the maximum draft required and as the holes have been drilled on an arc in this lower position, it is apparent that the hook can be placed in any hole without changing the setting. Now for the minimum; the beam is raised all the way up and the hook is shifted. It is apparent here also that the hole nearest the regulator will move farther, hence higher, than the hole on the fulcrum

end. In fact, the hole nearest the pivot end will travel in a more nearly horizontal direction than in a vertical one.

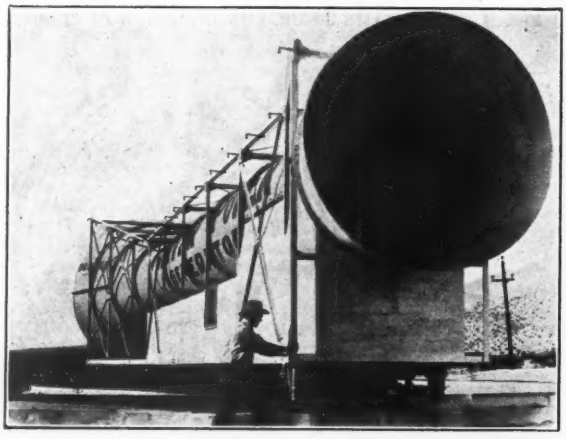
This arrangement as described has been in day and night operation for the past several years and it surely makes any regulator more than a stop and start affair. Any combination of maximum and minimum from 0 in. to 6 in. can be had by this device. We are using it on one to four 750-hp. boilers and run from rated load to as high as 250 per cent rating. As our load has very definite change periods, the water tender makes his adjustments about 5 min. prior to the change and does not bother himself again with it until the next change in load occurs. These change periods occur generally at about 7 a. m., 8 a. m., noon, 1 p. m., 5 p. m., 6 p. m. and 3 a. m.

The accompanying charts show in Fig. 2 how steadily the steam pressure was maintained under the extremely fluctuating load indicated in Fig. 3. In order to accomplish this draft, changes indicated in Fig. 4, which represents the air passage changes, were required. Both charts, which were obtained from recording gages, and the data plotted on the load curve Fig. 3, were obtained for the same 24-hr. run.

New Haven, Conn. FRANK E. FINGER.

Wind Power Electric Generator

THIS WIND power generator has just been completed in Southern California and is now producing electricity whenever the wind blows 4 mi. an hour or more. The present plant will develop 200 hp. from its wind motors.



WIND TUNNEL OF WIND-ELECTRICAL GENERATOR IS AUTOMATICALLY CONTROLLED SO AS TO CHANGE POSITION WITH CHANGE OF DIRECTION OF WIND

Propellers are mounted on a central shaft through the wind tunnel. A huge funnel at one end concentrates the wind onto these propeller blades which thus turns the shaft at an average of 180 r.p.m. The entire structure is mounted on a circular track-base in order to swing into the wind at any time a change may occur. Automatic electrical controls keep the large funnel directly in the face of the strongest wind.

A second wind power plant, to operate the generators, is now being constructed which will develop 1400 hp. It is the plan of the developers of this project to have these wind generators located in many different districts so that there will be a constant flow of electricity if the wind should fail in one spot. By having a dozen or more wind plants within a radius of 50 or 100 mi., there will always be enough in operation to keep the outgoing current fairly constant. The operation cost of these power plants will be extremely small because one man can look after a dozen or more.

Los Angeles, Calif. WILLARD D. MORGAN.

Pipe Plug Aids in Driving Cotter Keys

COTTER KEYS often fit a bit snugly and driving them in, frequently ruptures and springs the head out of shape. An old pipe plug can be used to advantage in

CUPPED OUT PART OF PIPE PLUG PREVENTS COTTER HEAD FROM SPREADING WHILE BEING DRIVEN

preventing this spreading. Most pipe plugs have the lower end cupped or hollowed out, and when the plug is used as shown to take the hammer blows, the key may better keep its shape as it goes in.

Missouri Valley, Iowa. FRANK W. BENTLEY, JR.

Pipe Thread "Dope"

DON'T BE SATISFIED with a can of "red lead and oil" for smearing all kinds of pipe threads before screwing them together. Take a hint from the air brake men, and use graphite mixed with almost any kind of oil; machine oil included. All piping, which is likely to be taken down frequently such as that around pumps, injectors, etc., should be put together with graphite and non-drying oil.

While joints may be made up with either white, red or yellow lead oxides, it is well to use such "dope" only in the joints of heavy pipes which are to be made up, with very little likelihood of ever being broken save in case of change or accident.

For permanent, underground pipes, it may be well to makeup their joints with litharge and glycerin, or with No. 1, "Smooth-On." If either substance be used,

it is likely that when such joints are taken apart, it will be done with hacksaws or the oxy-acetylene cutting torch. For shop air pipes, common beeswax is excellent and also works well with oil and gasoline pipes, for which ordinary yellow laundry soap is about as good a "dope" as can be found.

Sometimes, a stubborn leak in an air pipe may be stopped by making up the joint with a mixture of shellac and graphite. The application of heat to the made-up joint by means of a blow-torch, will hasten matters by slightly baking the shellac in the pipe-joint causing the shellac to "set" quickly and strongly.

Indianapolis, Ind. JAMES F. HOBART.

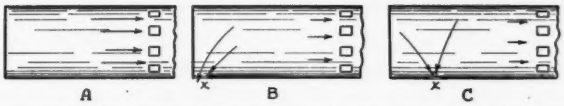
Counterflow and Uniflow Non-Condensing Engine Economies

LIKE MR. NICHOLAS I have studied Professor Stumpf's treatise on "The Una-flow steam engine," and find in so doing that it is very easy to draw wrong conclusions. The statement that auxiliary exhaust valves increase the clearance is only partly true, for they eliminate cupped pistons and clearance pickets and the total clearance is usually less as both types compress to boiler pressure and exhaust valves shorten the compression stroke. While it is true that the large clearance type does not loop the card at light loads, this is due partly to the fact that the real cutoff is so much greater than the apparent cutoff. The fact that exhaust valves are a partial reversion to the counterflow principle is not destructive to economy even though condensation loss is increased slightly, provided these valves are correctly located.

The following sketch may explain why the exhaust valves should be placed away from the cylinder head for best economy. The figures A, B, and C representing one end of a unaflow cylinder show methods employed by three different builders to limit compression in the noncondensing unaflow. The arrows show the path of the steam when exhausting. In A, the large clearance type, all exhaust leaves by the central ports, preserving the unaflow principle and giving minimum condensation loss. In B, the auxiliary exhaust valve is at point X and on the exhaust stroke the low temperature steam sweeps over the head and barrel with considerable condensation loss due to counterflow action, although clearance losses are less than in A. In C, the exhaust valve is at point X, a considerable distance from the head, which allows steam to be exhausted after the central ports are closed thus reducing clearance losses, but at the same time the exhaust steam does not sweep over the head or end of cylinder barrel, thus avoiding the large condensation loss inherent in type B. We must admit that the use of auxiliary exhaust valves in type C gives greater condensation loss than in A, but the sum of the clearance loss, condensation loss and incomplete expansion loss will be found to be less in C than in A and it is the reduction of the sum of all losses rather than complete elimination of one loss that spells real economy.

If A has a compression stroke of 90 per cent and C has 45 per cent or less, it is obvious that the clearance in A is double that of C. If we take an engine of type A with 10 per cent clearance and an apparent cutoff of 10 per cent of the stroke only 5½ expansions are realized, while with type C having 5 per cent clearance or less, 7 expansions are realized at an apparent cutoff of 10 per cent. The secret of the steam rates attained by this engine is the correct balance or compromise between initial condensation loss and the clearance and incomplete expansion losses. Total elimination of initial condensation is accomplished in type A but at some cost. The large amount of steam that must be compressed to practically initial pressure reduces the power output compared to a cylinder of the same size equipped with exhaust valves. If the mechanical efficiency of the engine is 90 per cent during the compressing operation and 90 per cent during the re-expansion of the compressed steam, it follows that for every shaft horsepower applied to compressing steam only 0.81 hp. is reclaimed by the re-expansion of this steam.

It should be borne in mind that the location of exhaust valves as in Fig. C is the invention of an American builder and Prof. Stumpf probably referred to



LOCATION OF AUXILIARY EXHAUST PORT HAS MUCH TO DO WITH ECONOMY OF OPERATION

the valve in Fig. B in his unfavorable comments on auxiliary valves. The figures below show results of tests on a noncondensing unaflow having exhaust valves properly located, and are quoted from the National Engineer.

Non-cond. 132 lb. steam, saturated	17.9 lb.
Non-cond. 165 lb. steam, saturated	16.8 lb.
Non-cond. 165 lb. steam, 101 deg. F. sprht.	14.0 lb.
Non-cond. 165 lb. steam, 138 deg. F. sprht.	13.6 lb.
Condensing 135 lb. steam, saturated	13.2 lb.
Condensing 165 lb. steam, saturated	12.9 lb.
Condensing 165 lb. steam, 98 deg. F. sprht.	10.6 lb.
Condensing 165 lb. steam, 135 deg. F. sprht.	10.2 lb.

This engine was also designed to operate economically under a back pressure of six pounds.

Springfield, Mass. A. F. SHEEHAN.

Always Heat Parts Into Which You Pour Babbit

ABOUT TWENTY years ago the late O. N. Trooien, who gave promise of becoming a great engineer, was babbiting some bearings. He was pouring the molten metal and I was holding the forms and observing closely. Suddenly there was an explosion and hot metal was blown into one of my eyes. Fortunately for me nature was kind and placed a new skin over my eye in about a week, removing all traces of a nasty burn. Many others have not been so lucky. Moral: Before pouring hot metal into any vessel, mold, form, shape, or anything, be sure that there is no water or moisture present. Enough moisture was present in this mold for the sudden generation of steam. It was the steam that blew the metal into my eye. Whenever possible, heat the bearing before pouring the metal, thus driving out all moisture and don't forget to wear goggles.

Newark, N. J. W. F. SCHAPHORST.

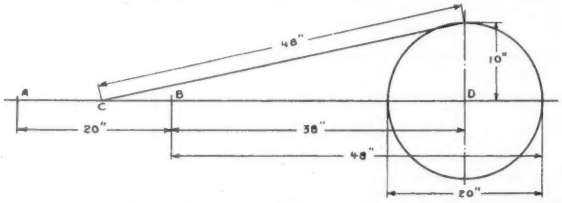
QUESTIONS AND ANSWERS

Position of Piston at 90 Deg. Crank

AN ENGINE has a 20-in. stroke. The length of the connecting rod is 48 in. At what point of the stroke is the piston when the crank is at 90 deg.?

E. G. M.

A. In the diagram illustrated, A and B represent the extreme positions of the piston and therefore the stroke, which is given as 20 in. This also is equal to the diameter of the crank circle. When the crank is at 90 deg., the crank, the connecting rod and the distance between the piston pin and crank shaft center



POSITION OF PISTON FOUND BY RELATION BETWEEN SIDES OF A RIGHT ANGLE TRIANGLE

represents a right angle triangle of which the connecting rod length—48 in.—is the hypothenuse, therefore

Distance C D squared $= 48^2 - 10^2$
$= 2304 - 100 = 2204$

Distance C D $= \sqrt{2204} = 47$

Since distance C B = C D — B D
$= 47 - 38$
$= 9$ which is the distance from the crank end of the stroke to the piston position.

Safety Valves Should Blow Consecutively

YOUR ANSWERS to the following questions would be appreciated:

1. A boiler is equipped with six safety valves, four of which are on the saturated steam drums and two on the superheaters; which safety valve should blow first, the saturated or the superheaters?

2. An insurance company grants a certificate certifying that the above boiler may be operated at a pressure not to exceed 275 lb. per sq. in. Where should the safety valve be set in order that boiler may be operated as near to the allowable pressure as possible?

A. If the safety valve on a superheater blows first, a sudden drop in superheat will result. Because of this, operators frequently set the superheater safety valve to blow off last, but if this is done there is a great likelihood that, since there would be only a slight flow of steam in the superheater under these circumstances, the superheater would become so hot that it would burn out and leak.

Best results are, therefore, obtained if one or more safety valves on saturated steam drums blow off before those on superheaters but one or more of those on saturated steam drums should also be set to blow off after those on superheaters have blown off.

2. One or more safety valves on the boiler should be set at or below the maximum working pressure. The remaining safety valves may be set within a range of 3 per cent above the maximum allowed working pressure but the range of all the safety valves should not exceed 10 per cent of the highest pressure to which any safety valve is set.

Having six safety valves, the first should be set to blow off at 275 lb. Adding 3 per cent to this we have 283 as the pressure at which the last safety valve should blow off. So we could set the six valves to blow off at the following pressures: 275, 277, 279, 280, 281 and 283. Or we could have intervals of 2 lb. and have two of the middle pressure valves blow off at the same pressure. It is best not to have many safety valves blow off at the same time because such procedure causes too great disturbance in the boiler. In the case mentioned, the superheater safety valves could best be set to blow off at 279 and 280 lb. respectively.

Rapid Heat Changes Cause Leakages

REFERRING to article on page 1209 of the November 15 issue by C. M. S., I dare say that if the furnace is of the so-called smoke preventing type used in the Chicago District, too much cold air may be admitted through the side or back damper or over the fire during excessive firing and thus cause unequal contraction and the greater portion of the tubes through the center part of the rear head, will leak.

If kerosene is used in the boiler to remove scale, it aggravates leakage trouble because it penetrates the small crevices around tube ends. A scale of ⅛ in. thickness on the tube sheets is likely to cause burning of the beads on the tube ends. Proper water treatment should be added at once and the boilers blown down at frequent intervals. If the tube ends have become burned, they cannot again be so rolled as to remain tight for any great length of time and the beads will crack and break off flush with the tube sheet.

During excessive firing, the feed pump may have been speeded up to cool down the boilers enough to prevent popping of the safety valves and in this way cause excessive contraction of the tubes, hence leakage. The pulsation of the feed pump would not have much effect on leakage of the tube ends unless the internal feed pipe discharged the water directly against the tube sheet. If this is the case, it would be better to have the internal feed pipe cross over to the other side of the tubes and in front of the rear head, then

extend forward, discharging downward between the center tubes so as not to strike the girth seams.

When boilers are cleaned out, I have found leakage may be greatly reduced by putting a few quarts of bran or corn meal in the manhole before adjusting the plate and filling the boiler with warm water. After standing for a short time, a hydrostatic test is made.

Cambridge, Mass. R. A. CULTRA.

REFERRING to a question by C. M. S. on "Rapid Heat Changes Cause Leakages" published on page 1209, I believe his trouble can be eliminated and, in the course of about 2 yr., entirely pay for itself as well as return a handsome bonus on the investment.

There is no excuse today for any engineer operating boilers in which scale ⅛ in. thick has formed. The first thing to do is to remove this scale and prevent its future formation. There are various excellent methods of preventing scale formation in the market, depending upon the nature of the feedwater, and reliable feedwater treatment concerns are prepared to guarantee a certain degree of purity after they have made adequate tests of the water.

Where the load fluctuates as much as indicated by C. M. S., it would be highly advisable to install a steam accumulator. The boiler could then be fired at a fairly steady rate while the heavy fluctuations would be taken care of by the accumulator and there would be very little drop in steam pressure at the boiler during heavy demands. The engine could receive its steam direct from the boiler while the presses would take their steam from the accumulator. The writer has seen such an accumulator operate under sudden demands amounting to 750 per cent of rating for periods of 10 to 12 min. while the boiler operated steadily at 150 per cent rating.

By installing a proper feedwater treatment system and an accumulator of proper size with an automatic control of water level, the boilers could be operated much more efficiently and maintain a constant steam pressure. The operation of the plant would also be simplified and the maintenance costs reduced to a minimum.

New York City. D. L. FAGNAN.

Short Stacks Vs. High Stacks

WE ARE PLANNING to build a new hospital and the question arises, shall we have a long stack or a short one for the power house. I would appreciate it, therefore, if you would let me know whether or not short stacks with forced draft are practicable for such an installation. The boilers are expected to be 250-hp. water-tube boilers and the power house will be separated from the main building. J. H.

A. A forced draft installation is practicable for any condition but these are other considerations than workability especially in a case such as a hospital plant.

Forced draft is intended merely to overcome the resistance of the fuel bed, hence it would only reduce the height of the chimney, under a natural draft system, about 25 ft. We believe you have "induced draft" in mind. With induced draft the "stack" could be reduced in height to that of a mere stub.

Where the temperature of the stack gases is lowered, as when an economizer is employed, it is necessary to install mechanical draft but there should be no reason for such installation under the conditions usually prevailing in a hospital power and heating plant.

The first cost of an induced draft installation would be much less than the corresponding cost of a stack under natural draft but with the former there is an operating cost. Where mechanical draft is employed, there should be duplicate fan installations.

Great objection would, however, be raised to a short stack installation because of the emission of stack gases and smoke which would be particularly annoying and unhealthful to patients in a hospital. We would, therefore, advise installing a high stack so that the gases would be distributed in the higher altitudes and so be of annoyance to nobody.

Fan Data for Counter-Current Dryer

WE INTEND to build a dryer for drying calcium citrate. The dryer is to be of counter-current tunnel type, the material moving on a system of endless belts against a flow of preheated air. The material, on entering, will be at 100 deg. F. and composed of 70 per cent water; it should leave the dryer, containing 4 per cent water. It will be fed on the belt in small lumps in a layer about 2 in. thick at a rate of 480 lb. of wet cake per hour, which would call for the evaporation of 330 lb. of water per hour. The tunnel will be 2 ft. wide by 1 ft high. Speed and length of belt to be so proportioned that material will remain in the dryer for 2 hr. Belts to be made from fine mesh wirecloth to allow for circulation from underneath.

Outside air here has an average temperature of 80 deg. F. and a humidity of 0.015; it will be preheated to from 190 to 200 deg. F. by drawing it over steam coils into dryer by means of a fan. Steam to be heated with live steam at 100 lb. gage. The limiting factor in drying citrate of lime is surface evaporation since diffusion throughout it is extremely rapid, due to its porous nature.

1. How many cu. ft. of air will have to be handled by the fan per min?
2. How many fan hp. will be required?
3. How many B.t.u. per min?
4. Should the fan be placed between the steam coils and dryer, forcing air through the tunnel or at the feed end of the dryer drawing air through the tunnel? B. P.

A. For drying, 4900 cu. ft. of air per min. will be required.

2. The fan would require a 3-hp. motor.

3. B.t.u. required for heating would be 12,000 per min.

4. The fan should be placed at the opposite end of the dryer from the steam coils. The fan should draw the air through the tunnel and a plenum chamber should be installed between the tunnel and the fan intake to reduce the velocity at that point so that any of the material drawn out of the tunnel would be deposited before going into the fan. The quantity of air which is required for the drying would cause a velocity through the size of tunnel mentioned of 3500 cu. ft. per min., which is a little too large. The tunnel should be increased at least 5 per cent in area so as to reduce this velocity.

EDITORIAL COMMENT

Is the Small Factory Doomed?

Is the small factory doomed? This is the question asked and answered in the December issue of Nation's Business by Thomas N. Carver. After a careful analysis of the advantages possessed by the large industry over the small one and of the disadvantages of large scale production that operate in the opposite direction, the author permits the inferences to be drawn that the small manufacturing concern has a large and definite field, that there are certain limitations upon the power of large industries to crowd out the small concern in the same line and that small industries are destined for further growth and development.

The principal advantage possessed by the large industry, says Professor Carver, is in its large sales organization, rather than its large manufacturing facilities. In addition, large size gives industry a bargaining and purchasing power, in both labor and material markets, and a power to conduct research not possessed by the small industry. On the other hand, small industries may have advantages in producing for local consumption, and in buying locally, thus reducing transportation costs. Then, too, there are certain industries whose success depends more on efficiency in production than upon efficiency in bargaining. Such industries tend to concentrate in producing units of the optimum size; that is, in units of the size that gives maximum production efficiency or gives lowest production costs. In many cases, such units are found to be comparatively small. To combine this efficiency in production with the bargaining power of a large industry, it may sometimes be desirable to combine a group of small producing units with a large sales and purchasing organization serving all of them. This plan has been tried in such organizations as the chain store and in some other cases. The trade association is designed to effect such a combination.

One of the factors militating against operation of the small industry is the comparative scarcity of high grade men available for the organization and management of such enterprises.

Another and extremely important factor in the conduct of the small industry is that of power supply. Where the processes of the industry are such as to justify the use of considerable exhaust steam for process work, the industry, whether large or small, can often afford to make its own power. Where such process steam demands do not obtain, the central station can in most cases supply power more cheaply than the industry can make it. The various principles by which the power problems of various types of industries can be worked out have been treated from time to time by the various power plant magazines and provide a never-ending topic of discussion, since each individual case must be decided on its own merits. It must be recognized, however, that the large industry no longer possesses the great advantage of cheap power that formed one of its strongest supports in years past.

Considering the above factors, together with several others that cannot be mentioned here, Professor Carver concludes that the small manufacturing concern will survive. Judging by what we observe in our studies of the power plants of the country, we are inclined to agree with him and to strengthen the statement by saying that they will flourish. It is true that many small organizations have been absorbed by large ones; at the same time, there seems to be feeling throughout industry that, although the entire organization of industry is changing, the former recognized advantages of large industry do not apply in all cases. The power plant engineer and the manufacturer of power plant equipment who are to be successful must keep themselves fully informed of new conditions and must be ready to adapt themselves to the trends of the times.

Efficiency or Red Tape

Briefly and concisely the relation of efficiency and red tape is summed up in the statement that "Red tape is efficiency gone stale." Although red tape is usually associated with government and business departments, it exists in many power plant organizations under that or other name.

Efficiency is a desirable feature in any and all organizations or departments, but the means of obtaining it are often so complicated that they not only defeat the purpose by breaking down the morale of the force but in themselves often cost more to keep up than the increased efficiency brings in.

It is only by maintaining the proper balance between departments and by keeping a few well-kept records and using those that are kept that this bugbear of red tape is avoided. Efficiency is an elusive quantity, extremely perishable, and heroic methods are sometimes necessary to keep it from going stale, or degenerating into a slough of red tape.

On Selecting Foremen

The true executive is one who can get others to do his work for him and do it properly. Without the ability to exercise good judgment in the selection of men, no one can attain the fullest measure of success. Great leaders of all time owe much of their position to the high value of their subordinates, since, in every case, the ability to recognize ability, obtain and retain exceptional personal service was one of the underlying factors of success.

It is exceedingly difficult to estimate a man's ability or leadership qualities. It is all the more difficult when that man has been in the employ of a company for a number of years and is just now meriting promotion.

Larger pay and responsibilities have as often broken as made men. For anyone to have worked for a long period under the guidance of another, the graceful and unabused assumption of authority is a trying and too often impossible task.

Employe good will is among the major assets of any concern. It is to be cherished by all men in executive or supervisory positions. Such good will cannot be had, if the foreman is arrogant or spineless, a "hale fellow well met" or a snobbish clam. Good will among employes will be lacking if the foreman fails to merit both the liking and respect of the men.

Nearly always it is good policy to have two or three men in line for every foreman's place. How such men act as "straw bosses" when temporarily put in charge constitutes a splendid test of ability and will often identify a man as being a capable foreman. Examples of mistaken judgment are often eliminated thereby.

To sift potential foremen until both qualifications and limitations are known, to train these men thoroughly in the methods and practice, then to impose temporary authority now and again to determine their ability to lead others, will provide any plant with leaders capable of developing loyalty and interest in the men.

Off Duty

Every once in a while, quite frequently in fact, we read in the columns of our daily papers and magazines of some startling prediction which will shortly revolutionize our mode of existence. Paul Poofball, the noted Paris designer of women's apparel, for instance, breaks the devastating news that skirts are going to be longer this winter, or Rene Dandruff, the renowned hair dresser, in a special dispatch from the Paris office of the Daily Blues, deals a knockout to bobbed hair. Again, Prof. Bassdrumovitch (whose real name is Smith), the famous conductor of the Nyack Philharmonic orchestra, makes the statement that jazz is on the decline and will, within a short time, be a matter of history. Simultaneous with this announcement, however, comes Saul Hash, the celebrated exponent of jazz, with the assertion that jazz will save the nation from musical decay. In another field, Dr. Bombast, D.D., I.H.P., discoursing on the curse of modernism, predicts an early return to the puritan ideals and moral standards of forefathers. And so on, from every column of newsprint, from every magazine page and from hundreds of lecture platforms, predictions of all kinds are hurled at us with incredible frequency and with increasing volume.

No field of endeavor is lacking in prophets. When Thelma Mardi Gras, the lovely movie star, steps off the "Century" at Chicago, on her way from Hollywood to Paris, she hurriedly predicts the emancipation of women from oppression by men or some equally inane thing. General Haywire, the famous chairman of the board of the Useless Deal Corporation, upon his arrival from Europe where he has been studying conditions, informs the boys of the press that the foreign market presents favorable aspects and that the coming year will be the "biggest in history." Immediately Useless Deal Common goes up two points but the next day drops back four. General Haywire, by the way, was a dollar-a-year man at Washington during the war.

From still another quarter of the landscape appears Husk McGurk, the distinguished pugilistic engineer, who recently knocked the world's h. w. c. into an hyperbolic orbit, with an assertion that pugs are literary fellows and that in the future they will all be devotees of the arts and letters with strong tendencies toward transcendental philosophy.

To cap the climax, Prof. Pav, astrologer and seer of Paris, announces through the columns of the world's greatest newspaper on December 29, that the end of the world will come in the summer of 1928. "The end of the world is imminent," says the learned prof, "but the globe will not be totally destroyed. The constellation Lion from the effect of some unknown force will explode. A tremendous noise will be heard all over the world—an immense block like a gigantic meteorite will fall on the earth—the earth will be jolted from its orbit but magnetic forces will prevent it from falling—Asia will escape from most of the trouble, as this continent is destined to be mistress of the world."

Now, we haven't the slightest doubt but that poor Prof. Pav is perfectly sincere in his prediction; so was the Indian who, with his partner coming out of a drunk, insisted that his partner was blind because he could not see the six turkey buzzards with high silk hats sitting at the foot of the bed. As a matter of fact, Prof. Pav's ravings are no more preposterous and based perhaps on more logical evidence (in his own mind) than the asinine prognostications of Dr. Bombast.

The role of the prophet is a tempting one and from time immemorial has been assumed by members of all classes of society. From the mysticism of the tribal medicine man to Prof. Hash's descantings on the future of jazz, the underlying motive is the same—the gain of power over their fellow men by the aspect of superior knowledge. Such superior knowledge is usually attributed either to divine favor or scientific knowledge.

Now, it is perfectly possible to predict future phenomena by means of scientific knowledge, in fact, if one could know the exact condition of all the electrons and protons in the universe at the present moment and understood all the laws which govern their actions, we could predict future events in the universe with any degree of accuracy. But in the class of prophets we have been considering scientific knowledge is woefully lacking. The only science Prof. Hash knows is that of making home brew. Similarly, General Haywire's predictions have as much scientific basis as a radio advertisement.

But the newspaper boys must live and the masses must be amused, so it is probable that as long as the prophets continue to multiply, they will be given space on the front pages. The gems of thought which radiate from the astute mind of Husk McGurk are without question of considerably greater importance to the world than the intelligence of a Bertrand Russell or a Havelock Ellis.

So hail to the prophets! Let them continue to multiply in great numbers—may their tribe increase. And when they have increased and multiplied in geometrical progression and otherwise perhaps a miracle may come to pass and Prof. Pav's dream come true. Let us hope.

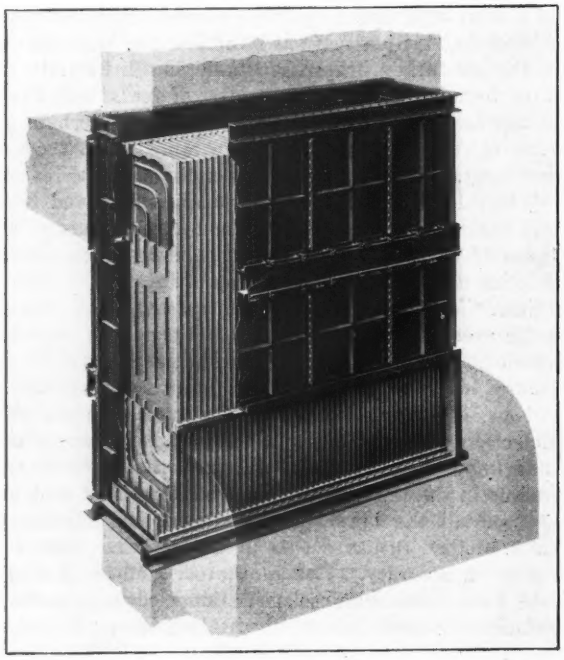
Yearly Index

INDEX for Volume XXXI of Power Plant Engineering is now prepared and will be sent free to subscribers upon request.

POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS

Recent Changes in Design of C-E Air Preheaters

CHANGES have recently been made in the design of the C-E plate type air preheaters as shown herewith, according to its manufacturer, Combustion Engineering Corp., 200 Madison Ave., New York.



SECTION OF C-E IN PREHEATER SHOWING NEW S-SHAPED AIR LANES NOW EMPLOYED

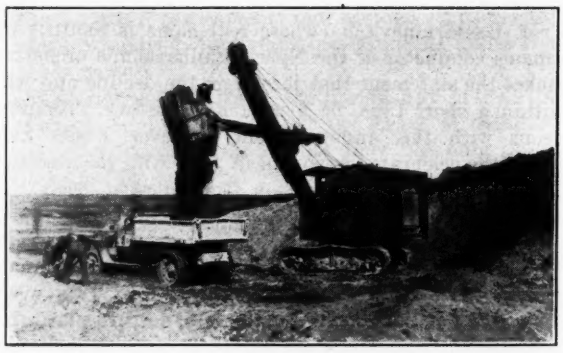
Access doors are provided in the heater casing to permit blowing the entire surface of the gas passages with steam or air lances. Wherever possible, two such doors are provided in each heater, located approximately one-quarter of the element length from each end of the element so that the entire heating surface can be blown. Opposite these doors the spacer bars in the gas passages are cut away to form a lane through which a lance can be inserted. These doors can readily be opened and are small enough so that the heaters can be cleaned while the unit is in operation.

To eliminate any leakage from the air side to the gas side of the preheater, the elements are welded to the casing by means of a sealing strip, which also holds the elements in place and permits expansion of the elements relative to the casing. This construction is intended to reduce greatly the amount of erection work necessary, as there are no bolted joints to be lined up.

Although a number of arrangements are possible with respect to air flow through the heater, it has been found that what is known as the "S" flow design results in the most effective transfer of heat from gas to air. In this design, the air inlet and air outlet are located on opposite sides of the heater, and the baffles are so arranged that all lanes of air travel are of approximately equal length, to assure an even distribution of air in all parts of the heater. The advantages of this construction, which derives its name from the fact that the air lanes are of "S" shape, warrant its use wherever possible.

New American Gopher Shovel-Crane

AMERICAN GOPHER Shovel-Crane, one of the latest additions to the American Family of shovels, cranes and derricks has recently been placed on the market. When work was started on the design of this



THE NEW AMERICAN GOPHER IN ACTION

machine, the engineers put themselves in the place of a man with a difficult digging job far from repair facilities and tried to produce a machine that would give the least possible trouble due to delays for repairs.

The American Gopher is equipped with continuous chain treads, (the American name for their crawler type mechanism) designed to enable it to travel over all types of ground, from mud to soft sand. The treads are flat in order not to harm pavement while traveling over city streets. There are holes in the treads so that cleats can be applied when it is necessary for the machine to travel over slippery places.

This new shovel-crane is equipped with high pressure lubrication, SKF bearings and parts interchangeable

wherever possible. To meet the demand for various kinds of power it comes equipped for either gasoline, Diesel power, or electric drive.

A booklet that tells all about the American Gopher Shovel-Crane will be sent upon application to the American Hoist and Derrick Co., 63 South Robert St., St. Paul, Minn.

Hardinge Co. Announces New Unit Coal Pulverizer

THE HARDINGE unit coal pulverizer, recently placed on the market, consists of the standard slow speed Hardinge conical ball mill and reverse current air classifier and is designed to combine the following features: continuous operation; control of the fuel to the burner at all times; constant fineness maintained at all times; one adjustment to regulate the fuel air supply and raw coal fed to the mill.

The unit is constructed so that with one adjustment, the amount of fuel to the burner can be instantaneously increased, decreased or shut off altogether, without stopping the mill.

In the schematic diagram, Fig. 1 herewith, the unit has been spread out the better to illustrate the principle

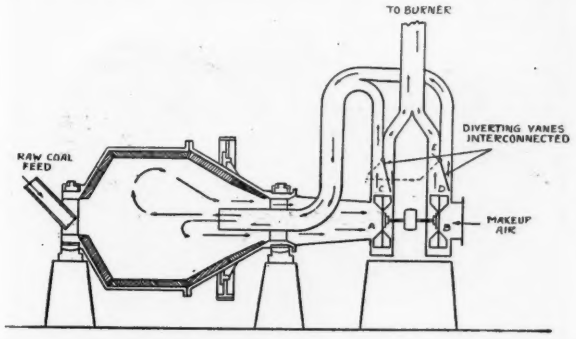


FIG. 1. SCHEMATIC DIAGRAM SHOWING PRINCIPLES OF OPERATION OF NEW HARDINGE UNIT PULVERIZER

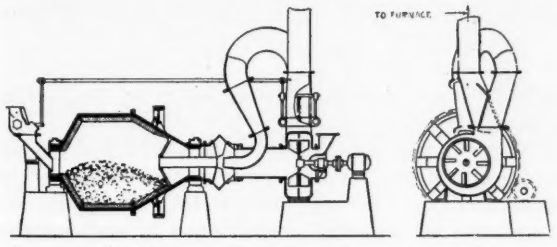


FIG. 2. CROSS-SECTION OF PULVERIZER AS ACTUALLY BUILT, SHOWING HOW THE TWO FANS ARE COMBINED

of operation. In practice, as shown in Fig. 2, the two small fans in Fig. 1 are combined as a duplex single-wheel fan in a casing having a vertical diaphragm. The diverting vanes are located in a similarly divided housing. One damper automatically controls both the flow of coal to the burner and the makeup air and is connected with the automatic feeder to the mill.

The mill is intended to act as a surge tank for an excess quantity of coal, and to enable the operator instantly to increase the load to any point, or to cut off the fuel entirely, without injury to the system, and without stopping the mill. Units are built in capacities ranging from 150 lb. an hour to 30 t. an hour. This unit pulverizer has been developed by the Hardinge Co., York, Pa.

Yarway Hi-Lo Alarm Water Column with Inclined Gage

DESIGNED FOR all working pressures up to 600 lb. per sq. in., the Yarway floatless Hi-Lo alarm water column, shown in the accompanying illustrations, has recently been placed on the market. The body of the column is forged from a single steel billet and

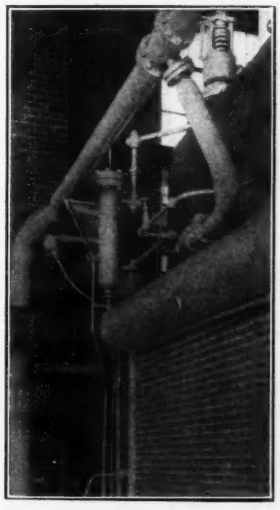


FIG. 1. NEW YARWAY WATER COLUMN INSTALLED AT MARCUS HOOK

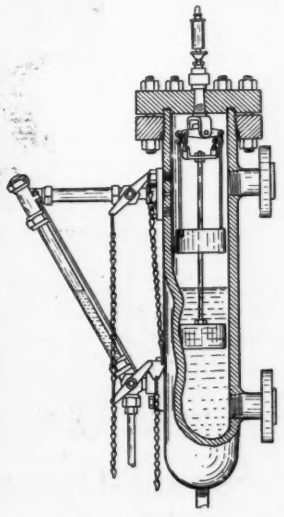


FIG. 2. CROSS-SECTION OF COLUMN SHOWING ACTION OF SOLID DISPLACEMENT WEIGHTS ACTUATING ALARM

fitted with two forged steel flanges at the top. For the higher pressures, boiler connections are flanged, shoulder threaded and arc-welded.

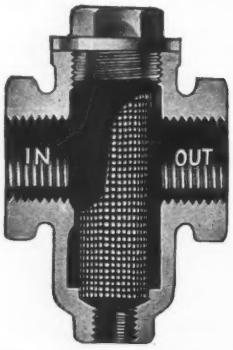
The Yarway Sesure inclined water gage is fitted to the column with flanged or screwed connections, depending on the pressure, and is supplied with standard try-cocks of any desired make. The inclined glass is intended to provide for positive water level reading on the high boilers now being installed in so many power plants. The gage glass is inclined at 60 deg. to the vertical, the upper leg of the gage is inclined slightly toward the column to prevent condensate from running down the glass and scoring it, and gage glass valves are close to the column so that pull on the chains will not strain the glass. All metal parts are of hydraulic bronze and any type of tubular, prismatic or flat glass can be supplied.

As shown, the Hi-Lo alarm depends for its action on the displacement of two solid weights suspended from balance levers. The whole assembly is in equilibrium at normal water level; when high or low water levels destroy this equilibrium, a rocking motion is imparted to the levers and this admits steam to the whistle. A Mercoid switch can be connected just below the

whistle to actuate a light or bell instead of, or in addition to, the whistle alarm. The new water column is a product of Yarnall-Waring Co., Philadelphia, Pa.

Watson & McDaniel Strainer

IN THE ACCOMPANYING illustration is shown the improved W. & McD. strainer for steam, water, air or oil piping, recently placed on the market by Watson & McDaniel Co., 147 N. 7th St., Philadelphia,

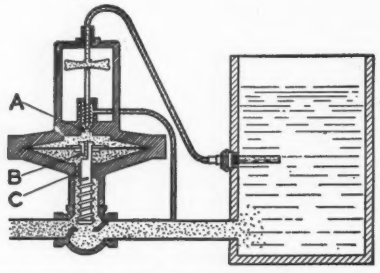


STRAINER IS DESIGNED WITH STRAIGHT FLOW PASSAGE

Pa. This is designed for installation in pipe lines to remove dirt, grit and scale and to protect valves, steam traps, air using equipment, fuel oil lines and the like. The strainer is designed so that the material flowing has a straight passage through it, with no obstruction to the free flow of liquid or gas.

Steam-Operated Controller Gives Close Regulation

FOR THE control of steam for various industrial purposes, the C. J. Tagliabue Mfg. Co. of Brooklyn announces the Tag Steam Operated Controller, to give the same service as the Tag Air Operated Controllers in plants where air pressure is not available.



CROSS SECTION OF THE STEAM-OPERATED CONTROLLER

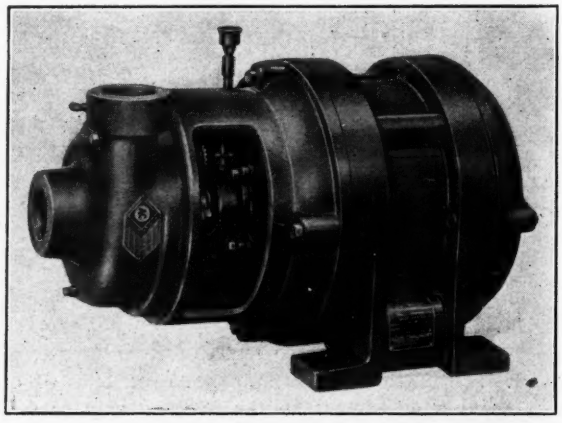
A cross section of the controller is shown in the illustration. The control element consists primarily of a sensitive bulb connecting tube and bellows for operating a pilot valve. The pilot valve in turn controls the flow of steam to the diaphragm. Whether the steam valve is open or shut steam is admitted to lower side of the diaphragm chamber through the opening "C" and then through the opening "B" in the diaphragm, which connects the space above the diaphragm with the space below. Steam can flow through this opening and if it is not allowed to escape from the upper portion, that is, when the pilot valve is closed, the steam pressure will be the same above and below the diaphragm so the spring loaded valve will close.

If the steam above the diaphragm is allowed to escape through the pilot valve opening "A", which is larger than the opening "B", the pressure above the diaphragm will be less than the pressure below the diaphragm and this pressure differential upward will act to open the steam valve against the pressure of the main spring.

Since the pilot valve in actual size is a small orifice requiring an insignificant amount of force for its operating and because this pilot valve is controlled by a sensitive thermostat temperature regulation, the valve is close and positive.

Allis-Chalmers Type "SSU" Centrifugal Pumping Units

AS SHOWN, the type SSU centrifugal pumping units recently brought out by the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., are combined motor and pump units of simple, compact, substantial



SINGLE STAGE TYPE SSU PUMP IS MOUNTED ON EXTENDED SHAFT OF MOTOR

design, the complete units being not much larger than a motor alone.

Both the pump and motor parts are built and guaranteed by the same manufacturer so there is no divided responsibility. This also insures that the pump and motor ends are properly proportioned to work together as an efficient, reliable unit. The unit is close coupled by fastening the pump impeller to one end of the liberal-diameter, extended motor shaft and the pump casing is bolted to a special integrally-cast extension of one of the motor end housings. This makes the simplest possible construction, eliminates a base plate, coupling, and pump bearings and is intended to do away with misalinement between the pump and motor. The motor bearings, which are the pump bearings as well, are over-size Timken tapered roller bearings, having ample thrust and radial capacity and mounted in dust-and-grease-tight housings. These bearings are designed to have practically negligible wear, to carry the thrust

of the pump impeller and to need only infrequent renewal of the lubricant.

The pumps are built in 1¼ by 1¼ in.; 1½ by 1½ in.; 2 by 2-in., and 2½ by 2½-in. sizes and can be used with 1, 1½, 2, 3, 5 and 7½-hp. motors. The capacities handled range from 25 to 200 g.p.m. against heads of from 50 to 100 ft.

Hotel Schroeder Nears Completion

ACCORDING TO present plans, the New Hotel Schroeder in Milwaukee will be opened about the 15th of February. This hotel, which is being erected for Chris Schroeder & Sons, 86 Michigan Ave., Milwaukee, will have 850 rooms and baths and in addition to being the largest hotel in Milwaukee will be one of the finest in the middle west. Holabird & Roche of Chicago are the architects.

Electric power will be purchased from the Milwaukee Railway and Light Co., although all electric circuits

ARCHITECT'S DRAWING OF THE NEW SCHROEDER HOTEL IN MILWAUKEE

and conduits are being made so that a separate engine or turbine room can be added at any time.

Three 350-b.hp. boilers will furnish steam for heating, cooking, laundry and auxiliary pump purposes. Two motor-driven CO_2 machines will be provided and complete air washing and ventilating equipment will be installed.

Work Started on Saluda River Project

WORK IS PROGRESSING RAPIDLY on the new Saluda hydroelectric plant now being constructed by the W. S. Barstow Management Association, Inc., of New York, on the Saluda River in South Carolina, according to a recent statement by the company. The main contract covering the construction of the dam itself was sublet to the Arundel Corp., Baltimore, Md. The building site is located approximately 10 mi. west of Columbia, S. C., on the Saluda River. The dam will be approximately 9000 ft. long, 208 ft. high, about one-quarter mile thick at the bottom and will contain 11,000,000 cu. yd. of earth placed by the semi-hydraulic fill method.

This earth dam will be the second largest in the world and the lake of approximately 76 sq. mi. with a shore line of 450 mi. will be the largest artificial lake in the United States. It has been said, at various times, that the available storage created by this lake will be sufficient to supply 200 mills of 350 hp. each, operating 24 hr. a day and 6 days a week, for a period of six months of complete drought. The original installation will consist of four units of 32,500 kw. each with provision for two additional units.

Murray & Flood of New York are the engineers on the whole project. The J. G. White Engineering Corp. of New York will have charge of the design of the dam and A. S. Crane, vice-president of that organization, will act as the consulting hydraulic engineer in connection with the project. The W. S. Barstow & Co., Inc., will design and construct the power house, substations, and transmission lines.

Initial installation is expected to be completed by 1930 so that power can be delivered from the station sometime during the summer of that year. At the present time the three-mile railroad connection to the C. N. & L. R.R. has been completed and the contractors are busily engaged in moving to prepare the site for the installation of the diversion works.

PRELIMINARY PROGRAM has been announced for the 34th Annual Meeting of the American Society of Heating & Ventilating Engineers, to be held at Hotel Pennsylvania, New York City, from January 23 to 26, 1928. On Monday, January 23, papers will be read by Dr. C. W. Brabbee, F. C. Houghten, S. R. Lewis and others, and various committee reports will be given. Past President's Dinner will be held on Monday evening. On Tuesday, in addition to committee reports, papers on ventilation, air conditioning and allied subjects, both for industrial and domestic applications will be given. Among the speakers will be Prof. F. B. Rowley, Prof. F. L. Fairbanks, H. P. Gant, W. C. Randall, and others. On Wednesday, January 25, papers on piping, boilers, heat transmission and other pertinent subjects will be delivered. On Thursday, data will be presented by Ole Singstad on the New Holland Tunnel and inspection trips will be taken through the Holland Tunnel and the new Brabbee Laboratory. Complete details regarding the meeting can be obtained from A. V. Hutchinson, Secretary, The American Society of Heating & Ventilating Engineers, 29 W. 39th St., New York City.

THE TEXAS-LOUISIANA POWER CO., Fort Worth, Texas, has begun the construction of an addition to its steam plant at Pecos, Texas. It is also making enlargements in its ice-manufacturing plant at the same place.

News Notes

West Texas Utilities Co. has recently acquired 5000 acres of land in Tom Green County as announced by E. V. Sellers. This includes six dams and a two-thirds interest in a seventh, with the idea of protecting San Angelo's water supply. It is expected that irrigation will be permitted so long as the water is plentiful. but with prior right for water supply to the city. With this purchase the company now has a water front of about 8 mi. on the South Concho River and about 7 mi. on the main Concho River.

Since December 19, the address of the headquarters office of the National Electric Light Association has been 420 Lexington Ave., New York, instead of 29 W. 39th St. The change in location has been made in order to house on one floor and under one roof, all headquarters departments and activities, in the interest of economical administration.

Link-Belt Co., Chicago, Ill., announces the appointment of four vice presidents, as follows: George P. Torrence at Indianapolis, in charge of Indianapolis operations and sales; George L. Morehead, Philadelphia, in charge of Eastern operations and sales; Frank B. Caldwell, in charge of the Chicago plant and sales offices; W. C. Carter, in general charge of production at all plants with headquarters at the general office at 910 S. Michigan Ave., Chicago.

France Packing Co., Tacony, Philadelphia, Pa., announces that Charles H. Bromley has joined its staff as vice-president. Mr. Bromley, who is well known in power and allied industrial fields, will participate largely in the management of sales and the shops, devoting particular attention to research in the further adaptation of metallic floating packing for high pressures and temperatures.

Stone & Webster, Inc., Boston, Mass., announces that Herman Mezger has joined its organization as an engineer in the electrical division. Mr. Mezger has been with Westinghouse Electric & Mfg. Co. and with the Brazilian section of the Foreign Department of the Allegemeine Elektrizitaets Gesellschaft of Berlin.

Apparatus has been developed by the Prest-o-lite Co. for the use of acetylene in the industrial field for pipe work. This will be found convenient in plant maintenance and production work because the gas is furnished in small containers and can be turned on and lighted the same as a gas jet, and turned off when not in use.

Murray Iron Works Co. of Burlington, Iowa, has bought the steam turbine business of the Standard Turbine Corp. of Scio, New York. The equipment has been removed to Burlington and work continued under the direction of J. Y. Dahlstrand, former president and engineer of the Standard Turbine Corp.

Mr. Dahlstrand developed and perfected the Standard turbine and his patents have been assigned to the Murray Iron Works Co. Turbines incorporating these features will hereafter be known as the Murray Standard Turbine and marketed as a part of the Murray line of engines and boilers.

The Murray Iron Works Co. has heretofore been known as builder of Corliss and Una-Flow engines, high duty pumping engines, water-tube boilers (vertical and horizontal), tubular and internally-fired boilers and the steam turbines complete this line of power plant machinery, according to Geo. G. Higbee, president.

It is expected that the existing sales representatives of the Standard turbine will continue their interest in the turbines. The owners of machines now in operation can rely upon getting parts from the Murray Iron Works Co., as all records, patterns and the like are now in Burlington.

Dearborn Chemical Co. announces that its new warehouse, plant and offices in Los Angeles, Calif., are located at 807 to 815 Mateo St. The brick and concrete building containing nearly 13,000 ft. of floor space was built in the summer of 1927 and the remainder of the ground area is used for oil tank storage. The plant is equipped with necessary tanks for the blending of lubricating oils for various individual requirements and for other products of the company such as No-Ox-Id. The Pacific Coast business of the company is managed by Alex B. Burns.

The Nugent Steel Castings Co., Chicago, Ill., announces that Van Cortright Mekeel, formerly with the Taylor-Wharton Iron & Steel Co., has joined its staff as special representative.

The Pittsburgh Valve, Foundry & Construction Co., Pittsburgh, Pa., announces the addition to its sales organization of Robert Whyte, who has been associated for many years with Pittsburgh Piping & Equipment Co. and the American Foundry & Construction Co.

Northern Equipment Co., Erie, Pa., announces the appointment of Hawkins-Hamilton Co., 502 W. Seventh St., Charlotte, N. C., as its representative. John H. Trescot is in charge of this office.

Lincoln Electric Co. announces the transfer of John Van Horne from Atlanta to 514½ Fifteenth St., Moline, Ill., covering the Tri-Cities.

Prat-Daniel Corp., 101 Park Ave., New York City, announces that W. H. Caldwell has joined its sales staff to handle sales in New York City and surrounding territory.

George E. Learnard, president of the International Combustion Engineering Corp., has announced the receipt of a cable advice from his British subsidiary, the International Combustion, Ltd., of the closing of an order with the Synthetic Ammonia & Nitrates, Ltd., at Billingham-on-Tees, England. The company will build all the equipment going into this plant, including six high-pressure steam generating units for 800 lb. pressure with generating capacity of 269,000 lb. an hour. Pulverized coal will be burned by the Lopulco system. The complete cost for the steam generating and combustion equipment, exclusive of other construction and equipment, will total upwards of $2,500,000.

Central Public Service Corp. of Chicago, through its subsidiary companies, has acquired the Rockford, Ill., Gas, Light and Coke Co. and the Rockford Electric Co. and has announced a $1,000,000 expansion program next spring which will entail construction of a new gas plant with coke ovens, prepared to burn Illinois coal for production of gas, replacing the present retort system. The Federated Utilities, Inc., of New York is purchaser of Rockford Gas, and the Central Gas and Light Co. buyer of the Rockford Electric Co. Adam

Gschwindt, former manager of the electric company will continue in that position with the new control and Henry S. Whipple will remain as manager of the gas and coke plant. The Central Public Service owns the Freeport Gas Co. and the Lincoln Water and Gas Co. and its plan for expansion of the Rockford unit will be a consolidation of its utility service in this community.

THE BOILER ENGINEERING CO., 931 Federal Trust Bldg., Newark, N. J., announces that it now owns and controls the Turner Boiler Baffle Wall, which was originated by T. G. Turner about 13 years ago together with J. W. Putnam. It is the intention of the Boiler Engineering Co., however, to recommend henceforth the Beco baffle wall, rather than the Turner baffle. The Turner baffle has been installed in boilers of about 2,000,000 capacity, but the company believes that the Beco provision for expansion is superior. The Turner baffle, however, will be furnished to those who specify it.

THE NORTON CO., Worcester, Mass., has purchased the entire capital stock of Bethel-Player & Co., Inc., Westboro, Mass., manufacturers of lapping machinery.

HENDRICK MANUFACTURING CO., Carbondale, Pa., announces the opening of a Chicago district office, 223 Railway Exchange Building, Chicago, in charge of Lon Sloan.

REEVES & SKINNER Machinery Co. of St. Louis and Kansas City, Mo., has been appointed agent for the Missouri district for C. H. Wheeler Manufacturing Co. of Philadelphia, Pa.

STONE & WEBSTER AND BLODGET announce the opening of a Philadelphia office in the Packard Building under management of William McM. Rutter and David Remer, resident vice-presidents.

STOCKHAM PIPE & FITTINGS CO., Birmingham, Ala., announces with regret the resignation of George B. Baldwin, vice-president in charge of sales. He has been with the company for many years, but has now organized his own company, George B. Baldwin & Co., to engage in the general plumbing and heating supply business in Chicago. He will be succeeded as vice-president in charge of sales by Douglas W. Stockham, secretary. Roy L. Stewart, former Pacific coast representative, will be manager of sales. Harry N. Hall has been appointed advertising and sales promotion manager, and Irving Lyon, steel sales engineer and manager of the Crandall Packing Co. at Birmingham for a number of years, has been appointed manager of the steel sales promotion department of the Stockham Co.

STEVENS & WOOD, INC., 120 Broadway, New York, have signed a contract covering the design and construction of a new power station to be known as the Deep Water Station. This will be owned jointly by The American Gas & Electric Co. and by the American Electric Power Corp. It will supply power for the Atlantic City Electric Co., and the Delaware Electric Power Co., which are subsidiary companies to the holding companies first mentioned. The plant will be located on the Jersey side of the Delaware River at Deep Water Point, opposite Wilmington, Del. It will be planned for an ultimate capacity of about 400,000 kw. It is probable that the initial installation will consist of two units, each of 50,000 kw. capacity. In the design of this plant consideration is being given to the use of 1200-lb. boiler pressure. It is expected that the station will be available for initial service about the end of 1929.

ACCORDING TO A RECENT announcement, the merger of the American Blower Co., Detroit, Mich., and the American Radiator Co., which has just taken place, brings together two of the oldest companies engaged in the manufacture of heating and ventilating, air conditioning, draft equipment and allied lines. It is stated that each company will operate in the future much the same as it has in the past, as far as the name, personnel and methods of each organization are concerned. The merger, however, is intended to make possible economies in buying, marketing and manufacturing. The executive offices of the American Blower Co. are at Detroit, Mich., while those of the American Radiator Co. are in New York City, with general sales and manufacturing offices at Buffalo, New York, and western executive office at Chicago.

DR. WILLIAM D. COOLIDGE has been awarded the Edison Medal by the Edison Medal Committee of the American Institute of Electrical Engineers for his contributions to the arts of incandescent electric lighting and the X-ray. Dr. Coolidge is assistant director of the research laboratory of the General Electric Co. He is a graduate of the Massachusetts Institute of Technology and of the University of Leipzig, and member of many scientific and technical societies.

H. W. BYERS, as president and general counsel, in association with H. L. Cory, vice-president and general manager and E. S. Cory, secretary-treasurer, has organized the Municipal Utilities Co., 526 Liberty Bldg., Des Moines, Iowa, to furnish engineering and consultation service to municipal power plants in this state and territory.

UTILITIES POWER AND LIGHT CO. of New York last week completed negotiations for the purchase of the Federal Public Utilities Co. of Dubuque, Iowa, a $15,000,000 concern, and the Central States Power and Light Corp. of Davenport, Iowa, representing an investment of $9,000,000.

THE BINGHAMTON LIGHT, HEAT & POWER CO., Binghamton, N. Y., has completed the installation of a new 35,000-kw. generating unit in its local power plant.

CITY COUNCIL, Eugene, Ore., has plans for a new hydroelectric plant on the McKenzie River for municipal service. The plant is scheduled for completion late in 1928. J. W. McArthur, Eugene, is engineer and Stevens & Koon, Spalding Bldg., Portland, Ore., are consulting engineers.

JULIAN D'ESTE, president and treasurer of the Julian D'Este Co. of Boston, Massachusetts, died on December 2, 1927.

CONSTRUCTION WORK OF subsidiary and affiliated companies of Standard Gas and Electric Co. now under way or authorized will add a total of more than 270,000 kw. of generating capacity to the resources of those companies, according to H. W. Fuller, vice president in charge of engineering and construction, Byllesby Engineering & Management Corp. Duquesne Light Co., Pittsburgh, has completed the installation of one 40,000-kw. unit in its Colfax Station and a second unit of the

same size will be ready for service very soon. This brings the capacity of Colfax to 260,000 kw. Louisville Hydroelectric Co. is completing the construction of a hydroelectric plant with installed capacity of 80,000-kw. at Louisville, Ky. The first 16,000-kw. unit of the 48,000-kw. prospect No. 2 development on the Rogue River in Oregon will soon be ready for service and the second unit shortly after the first of the year. Oklahoma Gas & Electric Co. is extending its Harrah Steam Station and will install an additional turbine unit of 30,000 kw. capacity. San Diego Consolidated Gas & Electric Co. is to install a new 25,000-kw. steam turbine unit, while Northern States Power Co. reports favorable progress on the 21,000-kw. hydro-electric plant at Chippewa Falls, Wis.

Central States Electric Co. has begun preliminary work on its 1928 program of expansion at its Iowa Falls Iowa, plant, which will mean a plant of 40,000-hp. capacity. The first unit will produce 4250 hp. and is a steam turbine unit. The steam plant will be operated with the hydroelectric plant built here several years ago by the Iowa Central States to utilize the Iowa river power facilities and furnish a water supply for its steam plant. The completed unit will easily provide for Central States requirements in this territory and provide large emergency supply.

Books and Catalogs

Mechanical World Year Book, 1928 edition, 348 pages with alphabetical index, diary and memoranda pages. Published by Emmott & Co., 65 King St., Manchester, Eng.

Prominent among the new material introduced in the 1928 edition of this popular handbook is a lengthy section of planetary gearing, and the British Engineering Standards Association tables of limits and fits. The sections on steam boilers, scale and corrosion in boilers, boiler settings and boiler chimneys have all been rewritten. The sections on ball and roller bearings have been revised and extended and new table enables the contents of horizontal tanks to be readily calculated. Revisions have been effected in the section on belt conveyors and many new illustrations introduced throughout the book.

Wilson-Snyder, Pittsburgh, Pa., in a new leaflet describes Wilson-Snyder long stroke, high pressure, balanced-valve slush pumps.

The Esterline-Angus Co., Indianapolis, Ind., in bulletin 527, publishes an article by R. S. Lowry on "How to Reduce Power Demand Charges."

The Denver Fire Clay Co., Denver, Colo., in bulletin 140 gives data for users of refractories. Part I is devoted to a general discussion of the subject and Part II to the particular refractories made by this company.

Andrews-Bradshaw Co., 530 Fourth Ave., Pittsburgh, Pa., is issuing bulletin No. 42, a calculation book for determining the savings that can be made in a plant by changing from ordinary steam to standard specification steam.

Centrifugal pumps, their types, designs and uses, is the subject of an illustrated book distributed by the De Laval Steam Turbine Co., Trenton, N. J. Separate chapters take up the requirements of pumps for general water service, power plant service, water works service, sewage and irrigation pumping, supplying high pressure water to elevators and hydraulic machinery, marine service, mine pumping, fire protection service, hot water heating and brine circulation service, handling oils and paper pulp, etc. The final chapter treats of pump characteristic curves and gives formulas and constants useful to the pump user.

Yeomans Bros. Co., 1433 Dayton St., Chicago, has just issued a circular describing the screenless sewage ejector and giving a list of over 300 installations of it.

The Engineer Co., 17 Battery Place, New York, announces a new catalog on Enco Baffle Walls and the Enco Cross Baffle. The book describes new and improved baffle constructions with horizontal and vertical boilers. The company will no longer furnish baffles made under the Turner patent.

M. H. Detrick Co., 140 S. Dearborn St., Chicago, Ill., has issued a 64-page, well illustrated bulletin showing applications and designs of Detrick arches and walls.

The Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia, Pa., has issued bulletin No. 677, entitled "Steam Purification." This discusses the need for purification, analyzes some of the causes of impure steam and discusses the Cochrane steam purifier designed to bring about the desired purification.

Wing turbine blowers for furnishing forced draft to both stokered and hand-fired boilers are described and illustrated in a new bulletin, No. 87, recently published by the L. J. Wing Mfg. Co., 352 W. 13th St., New York City.

Erie City Iron Works, Erie, Pa., in a recent four-page folder describes the Erie City Vortex Furnace designed to make possible the application of pulverized coal to small boiler furnaces. Another bulletin just issued by this company is a paper by Prof. W. J. Wohlenberg entitled "Some Fundamentals of Water-Cooled Furnace Design."

The Superheater Co., 17 E. 42nd St., New York, N. Y., is issuing a supplement containing the revised steam tables and charts that have been included in the revised seventh edition of "Superheat Engineering Data." These are in a form that can be pasted in the copies of the sixth edition to bring it up to date.

The Engineers Club, San Francisco, Calif., has published an attractive booklet describing the new home of the Engineers' Club of San Francisco, on the 14th and 15th floors of the new Insurance Center Bldg., Pine and Sansome Sts. This was dedicated recently, and the club hopes that it will become a focus of engineering activities in that district.

American Institute of Steel Construction, Inc., 285 Madison Ave., New York, has just issued a reprint of an address by Clyde T. Morris, Professor of Civil Engineering, Ohio State University, on Practical Design of Wind Bracing. Another bulletin contains reprint of an article on Tensile Working Stress for Rivets by C. R. Young, Professor of Structural Engineering, the University of Toronto. Both these papers were presented before the Fifth Annual Convention of the Institute in October, 1927.